INSTRUCTION MANUAL

MODEL 3001TC

California INSTRUMENTS

Invertron® AC POWER EQUIPMENT

An affiliate of Amstar CORPORATION

California Instruments

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California INSTRUMENTS

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Invertron®

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LIST OF DRAWING

ASSEMBLY REFERENCE DESIGNATOR	DRAWING NUMBER	TITLE
	C4250-906	OUTLINE DRAWING
	E4250-400	FINAL ASSEMBLY
	E4250-091	SCHEMATIC, UNIT AND OUTPUT AMPLIFIER
A1	D4250-720	PRE-AMPLIFIER AND CONTROL ASSEMBLY
	E4250-092	SCHEMATIC, PRE-AMPLIFIER AND CONTROL CIRCUIT
A2	C4250-401	RECTIFIER ASSEMBLY
A3/A4	E4250-414	OUTPUT AMPLIFIER
A101	C4500-713	P.C. ASSEMBLY, DELAY START BOARD
	C4500-085	SCHEMATIC, DELAY START CIRCUIT
A5	D4250-415	OUTPUT VOLTAGE SELECTOR ASSEMBLY
	D4250-079	SCHEMATIC, OUTPUT VOLTAGE RANGES
A7	C4250-704	CAPACITOR BUSS BOARD ASSEMBLY
A6	C4050-702	METER BOARD ASSEMBLY
	B4050-072	SCHEMATIC, METER CIRCUIT
A102	C4250-724	SCR SNUBBER BOARD
	C4250-602	SCHEMATIC, SCR SNUBBER

SPECIFICATIONS

MODEL 3001TC AC POWER SOURCE

All specifications are tested in accordance with standard California instruments test procedures and apply with a stable, low distortion input signal as generated by a T series plug-in oscillator.

POWER OUTPUT	3000VA at 110 to 130 volts output with power factor of unity to ±0.7. See the derating chart on the following page for operation at lower voltages and/or power factor.
OUTPUT VOLTAGE RANGES (Determined by rear loaded printed circuit assembly)	0 to 32.5 volts rms, 0 to 65 volts rms, 0 to 130 volts rms, and 0 to 260 volts rms.
TOTAL HARMONIC DISTORTION	Less than 0.5% distortion, 45 Hz to 600 Hz, and less than 1% distortion from 600 Hz to 2 KHz.
AMPLITUDE STABILITY (After one hour warm-up)	±0.25% for 24 hours at constant line, load, and ambient temperature conditions.
LOAD REGULATION* (on 130 volt range)	±1% over the range from 45 Hz to 2 KHz when tested at unity power factor. In addition, a load regulation adjustment permits the regulation to be adjusted to zero at any given line voltage, signal frequency and load conditions. Control resolution is 0.02%.
LINE REGULATION	±0.10% of full output for a ±10% line change.
FULL POWER FREQUENCY RANGE**	45 Hz to 2 KHz.
FREQUENCY RESPONSE	±0.5 dB from 45 Hz to 2 KHz.

* Load regulation degrades slightly on the 32.5 volt, 65 volt and 260 volt ranges for operation above 1.0 KHz. See Section 4.9.5 of this instruction manual for test procedure on these ranges.

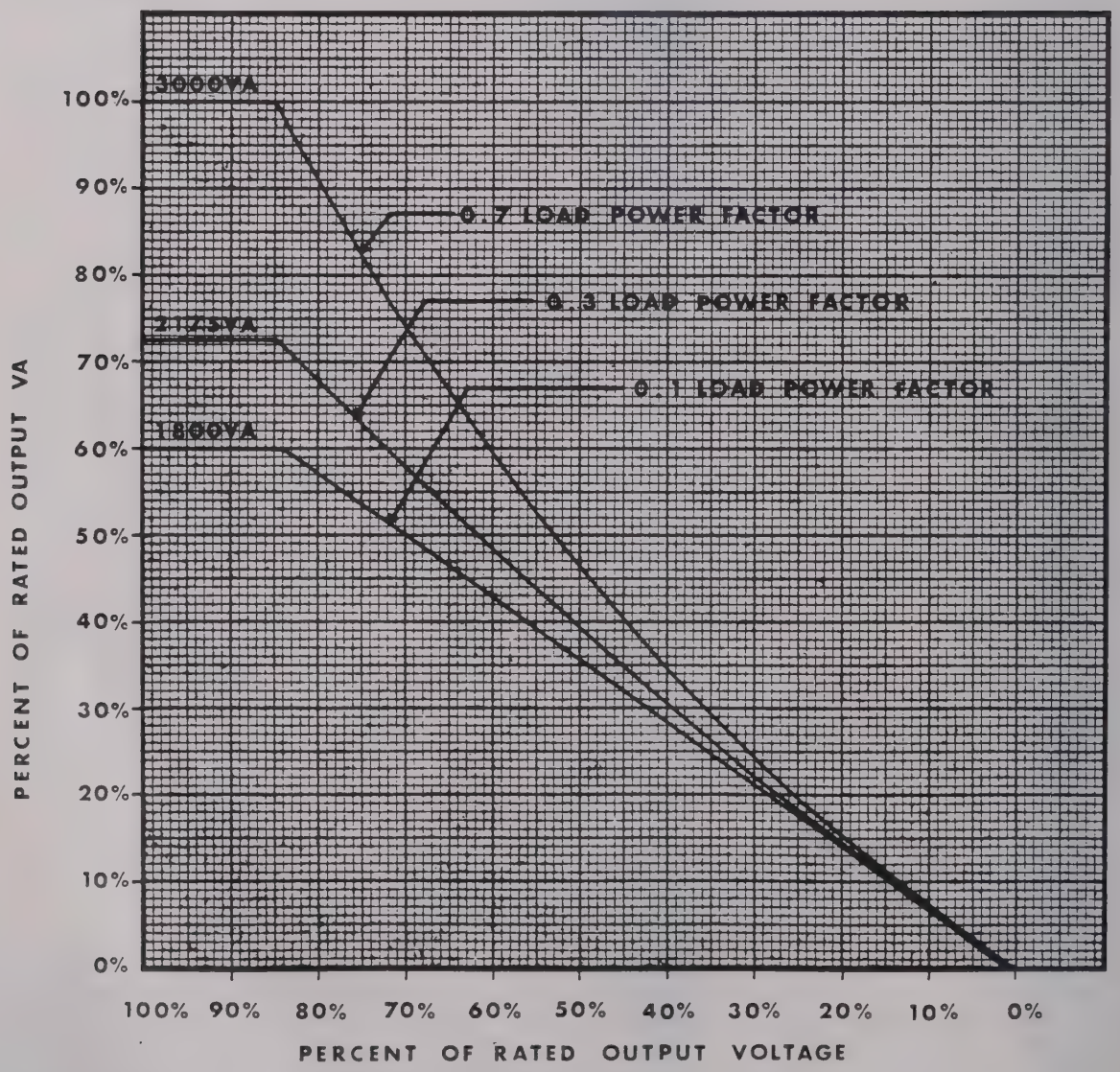
** This power source may be used over the 20 Hz to 20 KHz frequency range provided the output voltage and the output VA are derated according to Table 2-2 in this instruction manual; otherwise, permanent damage to the unit may occur.

AC NOISE LEVEL	50 dB below full output while measured at full power output.
CAPACITIVE LOADING	Output will remain stable under purely capacitive loads over the following ranges:
	32.5 V range 0 to 170μF
	65.0 V range 0 to 43μF
	135.0 V range 0 to 10μF
	260.0 V range 0 to 2.7μF
OVERLOAD AND SHORT CIRCUIT PROTECTION	Complete protection from overloads and short circuits is provided. Automatic instantaneous reset occurs when overload is removed.
THERMAL PROTECTION	Thermal overload circuit is activated if overload exists for a prolonged time period; if the unit is operated at an excessive ambient temperature; or if heatsink fan failure occurs. Automatic reset occurs when heatsink temperature returns to normal operating temperature.
AMPLIFIER DRIVE REQUIREMENTS (Normally obtained from plug-in)	5 volts rms (maximum) produces 130 volts rms.
AC INPUT LINE	208 volts L-L three phase, three wire. Unit may be wired for the following three-phase three-wire voltages on special order: 220 VAC, 230 VAC, 416 VAC, 440 VAC or 460 VAC. Also, the unit may be wired for three-phase, four-wire operation from 380 volts L-L.
AC INPUT FREQUENCY	48 to 65 Hz.
AC INPUT CURRENT	24 amperes rms per line maximum under high line and full rated load conditions from the 208 volt three-phase 60 Hz AC line.
	25 amperes rms per line maximum under high line and full rated load conditions from the 208 volt three-phase 50 Hz AC line.
OPERATING TEMPERATURE RANGE	0 to 55°C.

FRONT PANEL METER (Meter range also controlled by rear loaded printed circuit assembly)	0 to 40, 80, 160, 320 volts AC voltmeter provides ±1% of full scale accuracy at 400 Hz and ±3% of full scale accuracy over the range from 45 Hz to 2 KHz.
DIMENSIONS	15.75" high x 19" wide x 21" maximum depth.
NET WEIGHT	240 pounds.
SHIPPING WEIGHT	250 pounds.
FRONT PANEL FINISH	Grey, 26440 per Federal Standard 595 with black silk-screened lettering.

POWER DERATING CHART
FOR MODEL 3001TC POWER SOURCE

(Applies over the range from 45 Hz to 2 KHz. Derate the curve for output VA by 2.0 to 1.0 factor for operation above 2 KHz but less than 5 KHz; derate by 3.0 to 1.0 factor for operation from 5 KHz to less than 7.5 KHz; derate by 4.0 to 1.0 factor for operation from 7.5 KHz to less than 10 KHz; derate by 6.0 to 1.0 factor for operation from 10 KHz to less than 15 KHz; derate by 8.0 to 1.0 factor for operation from 15 KHz to 20 KHz.)



GENERAL DESCRIPTION

1.1 INTRODUCTION

This instruction manual contains information on the installation, operation, calibration, and maintenance of the California Instruments Model 3001TC Power Source. Detailed schematics, parts location, drawings, calibration procedures and theory of operation are also contained for the aid of maintenance personnel.

1.2 GENERAL DESCRIPTION

The California Instruments Model 3001TC Power Amplifier is a solid state, high performance, low distortion power source that provides up to 3000 VA output when used with the proper plug-in oscillator. The Model 3001TC Power Source is illustrated in Figure 1-1. Full power output is available in four different voltage ranges and over the frequency range from 45 Hz to 2 KHz. These full-power voltage ranges are:

1) 27.5 to 32.5 volts rms for applications where four units are to be stacked in series to provide 12 KVA at 120 volts.

2) 55 to 65 volts rms for applications where two units are to be stacked in series to provide 6 KVA at 120 volts.

3) 110 to 130 volts rms for normal single phase 115 volt applications and for three-phase 208 volt line-to-line applications.

4) 220 to 260 rms for normal single phase 230 volt applications.

For two-phase and three-phase operation, at least two power amplifiers must be combined together with the applicable multi-phase oscillator. Two power amplifiers will provide a total of 6.0 KVA two-phase power, or 6.0 KVA of three-phase power in the open delta configuration. Three power amplifiers will provide 9.0 KVA of three-phase power in the wye configuration.

1.3 ACCESSORY EQUIPMENT

The following accessories are available for use with the California Instruments Model 3001TC Power Source:

1.3.1 California Instruments Part Number 4250-221-1 rack slides. These rack slides may be bolted directly to the sides of the unit, if required.

1.3.2 Series 800T Variable Frequency Oscillators. These general purpose Wien Bridge Oscillators provide one phase, two phase or three phase outputs over the range from 20 Hz to 20 KHz in three bands. Units with single phase output are designated as 800T-20/20K-1-1ϕ, two phase oscillators are designated as 800T-20/20K-1-2ϕ, and three phase oscillators are designated as 800T-20/20K-1-3ϕ. Calibration accuracy is ±1 percent at 25°C and amplitude stability is 0.25 percent per 24 hours at 25°C. The total harmonic distortion is less than 0.25 percent from 20 Hz to 20 KHz. Several versions of the 800T Oscillator are also available which operate over a more restricted frequency range, but which provide improved frequency resolution.

1.3.3 Series 815T Fixed Frequency Oscillators. These low-cost fixed frequency oscillators provide one phase, two phase or three phase outputs over the range from 45 Hz to 10 KHz. Units with single phase output are designated as 815T-Freq-.1-1ϕ, two phase oscillators are designated as 815T-Freq-.1-2ϕ and three phase oscillators are designated as 815T-Freq-.1-3ϕ. Frequency accuracy is ±0.1 percent at 25°C. Amplitude stability is ±.25 percent per 24 hours at 25°C and varies less than 0.02 percent from 45 Hz to 10 KHz.

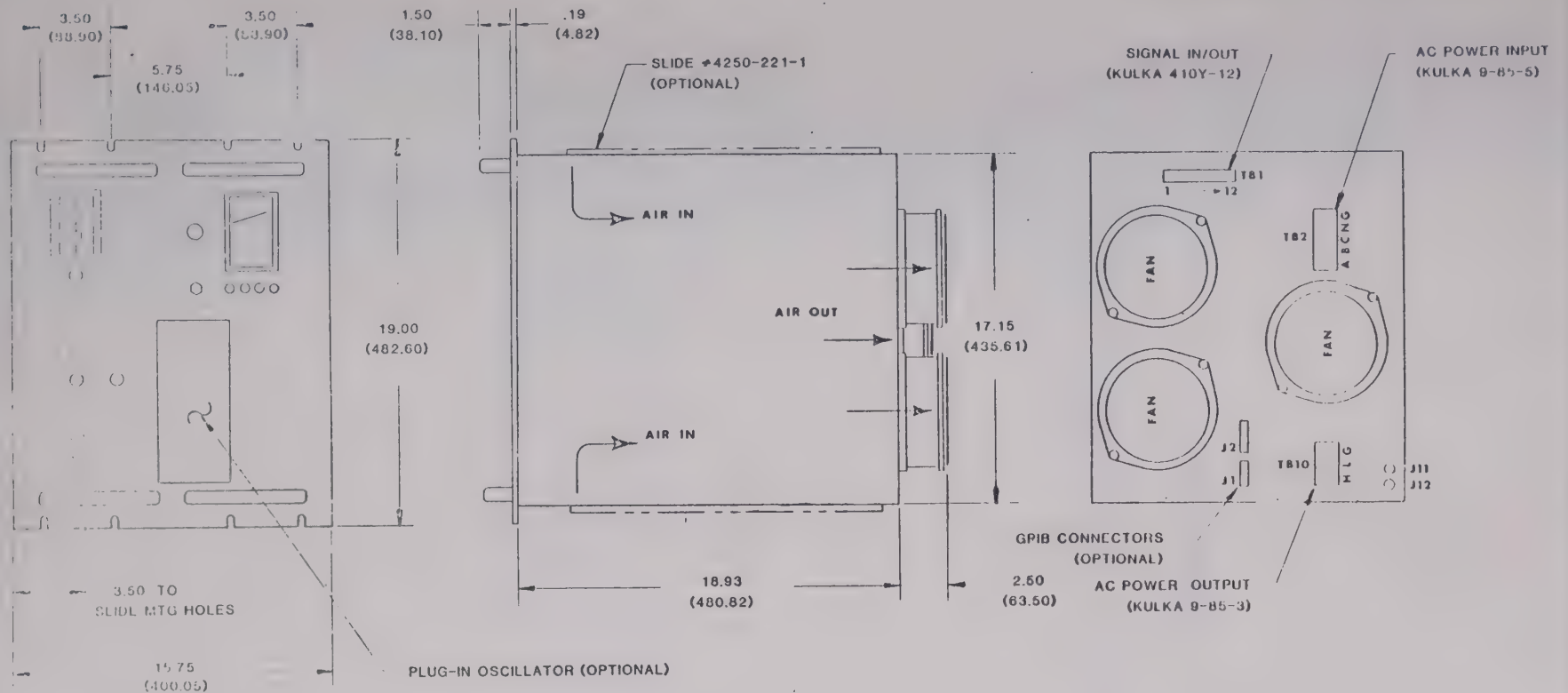
1.3.4 Series 835T Programmable Oscillators. These oscillators provide control of voltage amplitude, frequency, and phase angle in multiphase applications. Programming by either parallel BCD or IEEE-488 (1978) is available. These units are packaged in a separate 3.5 inch rack mountable chassis.

1.3.5 The Model 847T Programmable Oscillator is a digitally synthesized, crystal controlled oscillator featuring programmable amplitude and frequency via IEE-488 BUS or BCD parallel. The 847T Oscillators are available in single-phase, two-phase 90°, three-phase 120° WYE, and three-phase 60° DELTA configurations.

1.3.6 Series 850T Oscillators. These oscillators are decade dialing, digitally synthesized, and crystal controlled. Basic accuracy is ±0.005% of set frequency. Amplitude stability is 0.02% per 24 hours 23°C, ±0.01% per C maximum average temperature coefficient from 0 to 55°C. The total harmonic distortion is less than 0.15 percent from 45 Hz to 999.9 Hz, less than 0.3 percent 45 Hz to 9999 Hz.

OUTLINE DRAWING FOR MODEL 3001TC POWER SOURCE

DRW C4250-906



WARNING

Voltages up to 480 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with pin C and pin D of the plug-in oscillator, the primary power circuits, and the output circuits of the power source.

INSTALLATION AND OPERATION

2.1 UNPACKING

The California Instruments Model 3001TC Power Source is shipped in a cardboard container with protective inner packing. Do not destroy the packing container until the unit has been inspected for possible damage in shipment.

2.2 POWER REQUIREMENTS

2.2.1 The Model 3001TC Power Source has been designed to operate from any one of the following AC line voltages: 208 volts, 220 volts, 230 volts, 380 volts, 416 volts, 440 volts or 460 volts, three phase. The power transformer is normally wired at the factory for operation from the 208 volt, three phase, three wire AC line. Table 2-1 below indicates how the primary connections to the power transformer are made for various AC input line voltages.

Note:
Prior to reconnecting power transformer T1, remove all existing jumpers from the primary winding except those to pins 1, 10 and 19. Connect CB1, phase "A" load terminal to T1-pin 2; connect CB1, phase "B" load terminal to T1-pin 20; connect CB1, phase "C" load terminal to T1-pin 11.

Nominal Input Voltage	Operating AC Line Voltage Range	Power Transformer Connections	Front Panel Circuit Breaker Value
208 volts L-L three, phase, three wire	187.2-228.8 volts L-L	Jumper pins 2, 6, 21, and 25; jumper pins 3, 7, 11, and 15; jumper pins 12, 16, 20 and 24.	25 ampere three phase, 250 volt circuit breaker.
220 volts L-L Three phase, three wire	198-242 volts L-L	Jumper pins 2, 6, 22, and 26; jumper pins 4, 8, 11, and 15; jumper pins 13, 17, 20 and 24.	25 ampere three, phase, 250 volt circuit breaker.
230 volts L-L three phase, three wire	207-253 volts L-L	Jumper pins 2, 6, 23, and 27; jumper pins 5, 9, 11, and 15; jumper pins 14, 18, 20 and 24.	25 ampere three phase 250 volt circuit breaker.
380 volts L-L three phase, four wire	342-418 volts L-L	Jumper pins 2 to 6; jumper pins 11-15; jumper pins 20 to 24; jumper pins 4, 8, 13, 17, 22 to 26 and connect to neutral of TB2 through #12 wire.	15 ampere three phase, 480 volt circuit breaker.

TABLE 2-1

Nominal Input Voltage	Operating AC Line Voltage Range	Power Transformer Connections	Front Panel Circuit Breaker Value
416 volts L-L three phase, three wire	374.4-457.6 volts L-L	Jumper pin 2 to 25; jumper pin 3 to 6; jumper pin 7 to 11; jumper pin 12 to 15; jumper pin 16 to 20; jumper pin 21 to 24.	12 ampere three phase, 480 volt circuit breaker.
440 volts L-L three phase, three wire	396-484 volts L-L	Jumper pin 2 to 26; jumper pin 4 to 6; jumper pin 8 to 11; jumper pin 13 to 15; jumper pin 17 to 20; jumper pin 22 to 24.	12 ampere three phase, 480 volt circuit breaker.
460 volts L-L three phase, three wire	414-506 volts L-L	Jumper pin 2 to 27; jumper pin 5 to 6; jumper pin 14 to 15; jumper pin 23 to 24; jumper pin 9 to 11; jumper pin 18 to 20.	12 ampere three phase, 480 volt circuit breaker.

TABLE 2-1 (CONT.)

2.2.2 The Model 3001TC has been designed to operate over the line frequency range from 48 to 65 Hz. On special order, units will be supplied to operate from the 400 Hz line.

2.2.3 The normal rms input current on the 208 volt L-L range, at rated output power, is between 18 amperes and 24 amperes per leg depending on line and load conditions. During "turn-on," the peak transient will not exceed 25 amperes per leg.

2.3 CIRCUIT BREAKER REQUIREMENTS

The Model 3001TC Power Source uses a 25 ampere Heinemann CF3-G3-U-25-240-3 circuit breaker for operation from the 208 through 230 volt three phase AC lines. A Heinemann CF3-G3-U-15-480-3 circuit breaker is used for operation from the 380 volt three phase four wire AC line. A Heinemann CF3-G3-U-12-480-3 circuit breaker is used for operation from the 416 through 460 volt three phase AC lines. Substitution of circuit breaker type or current rating may cause permanent damage to the unit.

2.4 OUTPUT VOLTAGE, METER RANGE, AND FRONT PANEL RANGE INDICATOR

2.4.1 The output voltage available from the Model 3001TC Power Source is determined by a rear loaded printed circuit assembly. This assembly plugs into a connector set located inside the power source and accessible by removing the small plate at the rear of the unit. Rotate the printed circuit assembly until the desired output voltage range has been found, and then re-insert the printed circuit assembly into the connector and replace the cover plate.

2.4.2 This assembly is also used to select the proper range for the front panel voltmeter and to illuminate the proper front panel range indicator lamp.

2.5 ACCEPTANCE TEST PROCEDURE

Inspect the unit for any possible shipping damage immediately upon receipt. If damage is evident, notify the carrier. DO NOT return an instrument to the factory without prior approval. If the unit appears in good condition, perform the following.

2.5.1 Connect the AC power input (TB2) to a three phase AC power line of the proper voltage and frequency as determined by either the serial number tag on the unit or by inspection of the wiring to the primary of the power transformer (See Section 2.2 of this instruction manual.). Connect a 15 KW three phase Variac and a 0 to 25 ampere true rms meter in series with each leg of the three phase AC line. The Model 3001TC Three Phase Power Source should draw less than 2.0 amperes per leg under no load conditions at mid-line voltage from the 60 Hz AC line. The Model 3001TC Three Phase Power Source should draw less than 4.0 amperes per leg under no load conditions at mid-line voltage from the 50 Hz AC line. If a problem is encountered, perform Step 4.3.2 of the CALIBRATION PROCEDURE.

2.5.2 Using either a California Instruments 800T Series Oscillator or a suitable external low distortion sine wave oscillator, set the oscillator to the desired frequency (between 45 Hz and 2 KHz) and adjust the output of the oscillator to 5 volts rms. The amplifier input is available at pin 2 (tie oscillator ground to pin 1) of the small terminal strip TB1 located on the rear of the unit if the external oscillator is employed. Tie a jumper strap from pin 2 to pin 3 of TB1 if an 800T Series Plug-in Oscillator is being used as the signal source.

2.5.3 Select the proper output voltage range according to the procedure given in Section 2.4 of this instruction manual. The following table lists the proper external load for full power output on each of the voltage ranges.

Output Voltage Range	Output Voltage	Full Power Load Resistance	50 Percent Power Load Resistance
0-32.5 volts rms	32.5 volts rms	0.35 ohms	0.71 ohms
0-65 volts rms	65 volts rms	1.41 ohms	2.82 ohms
0-130 volts rms	130 volts rms	5.63 ohms	11.27 ohms
0-260 volts rms	260 volts rms	22.53 ohms	45.07 ohms

2.5.4 Connect the proper 3000 watt load resistor to the large output terminals at the rear of the power source that are labeled "POWER OUTPUT HIGH-LOW." Connect a Tektronix Model 533A Oscilloscope or equivalent across this load resistor.

2.5.5 Using the GAIN control and the proper range on the front panel METER, set the output voltage to the rated voltage of the unit as determined in Section 2.5.3 of this manual. The rms input current line meters should indicate between 18 and 20 amperes per leg at 208 volts L-L input from the 60 Hz AC line. Check on the oscilloscope for peak clipping or excessive distortion of the sine wave output.

2.5.6 With the output still adjusted as determined in Section 2.5.5, place a resistor in parallel with the external load resistor to provide a 50% overload on the output of the power source. The value of this resistor is given in Section 2.5.3 of this manual. The signal on the oscilloscope should exhibit significant clipping on both the positive and negative peaks.

The front panel circuit breaker may be activated if this 50 percent overload remains on the output of the 3001TC for more than a few seconds. The front panel circuit breaker cannot usually be immediately reset. Wait 30 seconds to one minute before attempting to reset the circuit breaker.

2.5.7 Remove the 50 percent overload resistor, and the output should automatically return to normal unless the front panel circuit breaker was activated due to the 50 percent overload.

2.5.8 Place a short circuit in parallel with the external load resistor, and then remove the short circuit after one second. The signal on the oscilloscope should go to zero and then return to normal when the short circuit is removed. The front panel circuit breaker and/or thermal overload may be activated if the short circuit remains across the output for more than a few seconds.

2.5.9 The CALIBRATION PROCEDURE given in Section 4.0 of this manual should be followed if a more detailed evaluation of the unit is required at this time.

2.6 MECHANICAL INSTALLATION

The Model 3001TC Power Source has been designated for rack mounting in a standard 19-inch rack. The unit should be supported from the bottom with a shelf-track or supported from the sides with a pair of rack slides (California Instruments Part Number 4250-221 or equivalent).

The cooling fans on the rear of the unit must be free of any obstructions which would interfere with the flow of air. A 2.5 inch clearance should be maintained between the rear of the fans and the rear door of the mounting cabinet. Also, the air intake holes on the sides and rear of the power source must not be obstructed.

2.7 INPUT POWER WIRING

The Model 3001TC Power Source will operate from three phase input voltages from 208 volts to 460 volts L-L in seven ranges as described in Section 2.2 of this manual. The power source should be used with 208 volt three phase lines with a capacity of 25 amperes or greater. If 380 to 460 volt AC lines are used, their capacity should be 15 amperes or greater.

2.8 OUTPUT POWER WIRING

The power output wires should be large enough to avoid excessive line voltage drops. The front panel regulation control is capable of providing greater than 3 percent over regulation for all normal load conditions. If it is desired to provide a zero output impedance at the load side of the power wiring, it is necessary that these line drops be limited to approximately 1 to 3 percent of the required output voltage. The following table lists the minimum acceptable wire size for the given percent line drop, assuming a 3000 VA output at a distance of 20 feet from the power source to the load.

Output Voltaged	Percent Line Drop	Maximum Line Drop	Load Current	Loop Length	Minimum Required Wire Size
32.5 volts	3.0%	0.975 volts	92.31 amperes	40 feet	#4
65 volts	2.0%	1.3 volts	46.15 amperes	40 feet	#8
130 volts	1.0%	1.3 volts	23.08 amperes	40 feet	#11
260 volts	0.5%	1.3 volts	11.54 amperes	40 feet	#14

The wire size should be reduced 3 sizes every time that the distance between the power source and load is doubled, but it is limited to number four by the size of terminal block TB10. The minimum wire size is further limited by the load current according to the table below, at an ambient temperature of 25°C.

LOAD CURRENT	WIRE SIZE WITH 105°C PVC INSULATION	WIRE SIZE WITH 80°C PVC INSULATION
90 amperes	#6	--
45 amperes	#10	#6
22.5 amperes	#14	#10
12.0 amperes	#18	#14

Full power output is available from the rear panel output (TB10) on all ranges of the power source. The front panel output terminals will supply full power output on the 260 volt and 130 volt ranges, but should be limited to 1500 VA and 750 VA, respectively, on the 65 volt and 32.5 volt ranges.

2.9 FRONT PANEL CONTROLS

2.9.1 The three phase circuit breaker, located on the front panel of the Model 3001TC Power Source, is used to switch the POWER to the unit "ON." At this time, the amber indicator lamp located above this circuit breaker should glow.

2.9.2 The GAIN control is used to adjust the output voltage level of the power source. In the case of a multi-phase power system, the GAIN control is turned nearly fully clockwise and then used as a fine gain trim control. The amplitude of the output of the multi-phase system is controlled by the AMPLITUDE control located on the multi-phase oscillator.

2.9.3 The REG control is recessed behind the front panel and is screw-driver adjustable. This control is used to vary the output impedance of the power source. Turning this control in the clockwise direction reduces the output impedance of the power source. If this control is rotated far enough in the clockwise direction, the power source will exhibit a negative output impedance and may be used to compensate for line voltage drops between the output of the power source and the load. Section 2.8 includes additional information on the possible application of this control.

2.9.4 The RANGE lamps on the front panel indicate which output voltage range, 0 to 32.5 volts, 0 to 65 volts, 0 to 130 volts, or 0 to 260 volts, is activated by the rear loaded printed circuit card. The corresponding voltmeter ranges are 0 to 40 volts, 0 to 80 volts, 0 to 160 volts, and 0 to 320 volts, full scale, respectively.

2.9.5 The EXCESSIVE LOAD lamp on the front panel indicates if the power source is being loaded excessively. This lamp may be activated momentarily during start-up of a nonlinear load such as an AC motor load or an incandescent lamp load.

2.9.6 The THERMAL OVERLOAD lamp on the front panel indicates if the output stage is operating at an excessive temperature. When this occurs, the output power is automatically reduced to zero. When the heatsink cools sufficiently, the output power will automatically return to its previous value.

2.9.7 The front panel circuit breaker will be activated if the power source is loaded with an excessive amount of shunt capacitive load. If shunt capacitors are used to correct the power factor of an inductive load, connect a small amount of resistance in series with the shunt capacitor. The value of this resistor should be equal to approximately 10 percent of the reactance of the shunt capacitor at the operating frequency of the system.

2.10 OPERATION OVER EXTENDED FREQUENCY RANGE

2.10.1 This power source must not be driven at signal frequencies below 20 Hz or above 20 KHz; otherwise permanent damage to the unit may occur. For operation in the region between 20 Hz and 45 Hz and for operation in the region between 2 KHz and 20 KHz, derate the output voltage and output power according to Table 2-2, on the following page, in order to provide reliable operation of the power source.

Output Frequency	Maximum Safe Output Voltage from Single 3001TC Power Source				Maximum VA Output at Maximum Safe Output Voltage with ±0.7 Power Factor Load
	32.5 Volt Range	65 Volt Range	130 Volt Range	260 Volt Range	
20 Hz	14.4V	28.9V	57.8V	115.6V	1200 VA
30 Hz	21.7V	43.3V	86.7V	173.3V	2100 VA
40 Hz	28.9V	57.8V	115.6V	231V	3000 VA
45 Hz to 2 KHz	32.5V	65.0V	130V	260V	3000 VA
greater than 2 KHz but less than 5 KHz	16.2V	32.5V	65V	130V	700 VA
5 KHz to less than 7.5 KHz	10.8V	21.7V	43.3V	86.7V	280 VA
7.5 KHz to less than 10 KHz	8.1V	16.2V	32.5V	65V	150 VA
10 KHz to less than 15 KHz	5.4V	10.8V	21.7V	43.3V	62 VA
15 KHz to 20 KHz	4.06V	8.1V	16.2V	32.5V	35 VA

TABLE 2-2

THEORY OF OPERATION

3.1 GENERAL

The California Instruments Model 3001TC Power Source is an all silicon solid-state 3000 VA amplifier and with companion oscillator is designed to provide reliable sine wave AC power over the frequency range from 45 Hz to 2 KHz.

A block diagram for the amplifier is shown in Figure 3-1. The pre-amplifier A1G1 is used to amplify the input signal to such a level so as to supply adequate drive to the power amplifier A1G2.

The power amplifier A1G2 provides the necessary sine wave signal to drive the output transformer T2. The output transformer has floating secondary windings which allow the load to float from the amplifier and oscillator circuitry.

The power amplifier A1G2 contains the overload and short circuit protection circuitry. A local negative feedback loop is taken from the output of the power amplifier back to the pre-amplifier, A1G1.

The overall negative feedback is taken from the feedback winding of the output transformer back to one input of the pre-amplifier via resistor A1R4. This feedback provides a closed loop gain of 8.5 from the high side of A1R1 to the primary of T2.

The positive feedback signal is generated by sensing the IR drop across the primary of T2 and applying this signal to transformer A1T1. Transformer A1T1 converts this differential signal into a single-ended signal and applies it to the input of the pre-amplifier through a divider network containing the regulation control R9. As this positive feedback is increased from zero with potentiometer R9, the output impedance of the power source is reduced toward zero.

Delay start assembly A101 provides the necessary time delay between application of input power and the application of the drive signal to power amplifier A1G2 output stages.

The multiple secondary of transformer T2 is interconnected by means of a set of rear loaded printed circuit boards, assembly A5. The rotation of this assembly is used to determine the output voltage range of the power source. This assembly also controls the front panel range lights and the range of the front panel voltmeter.

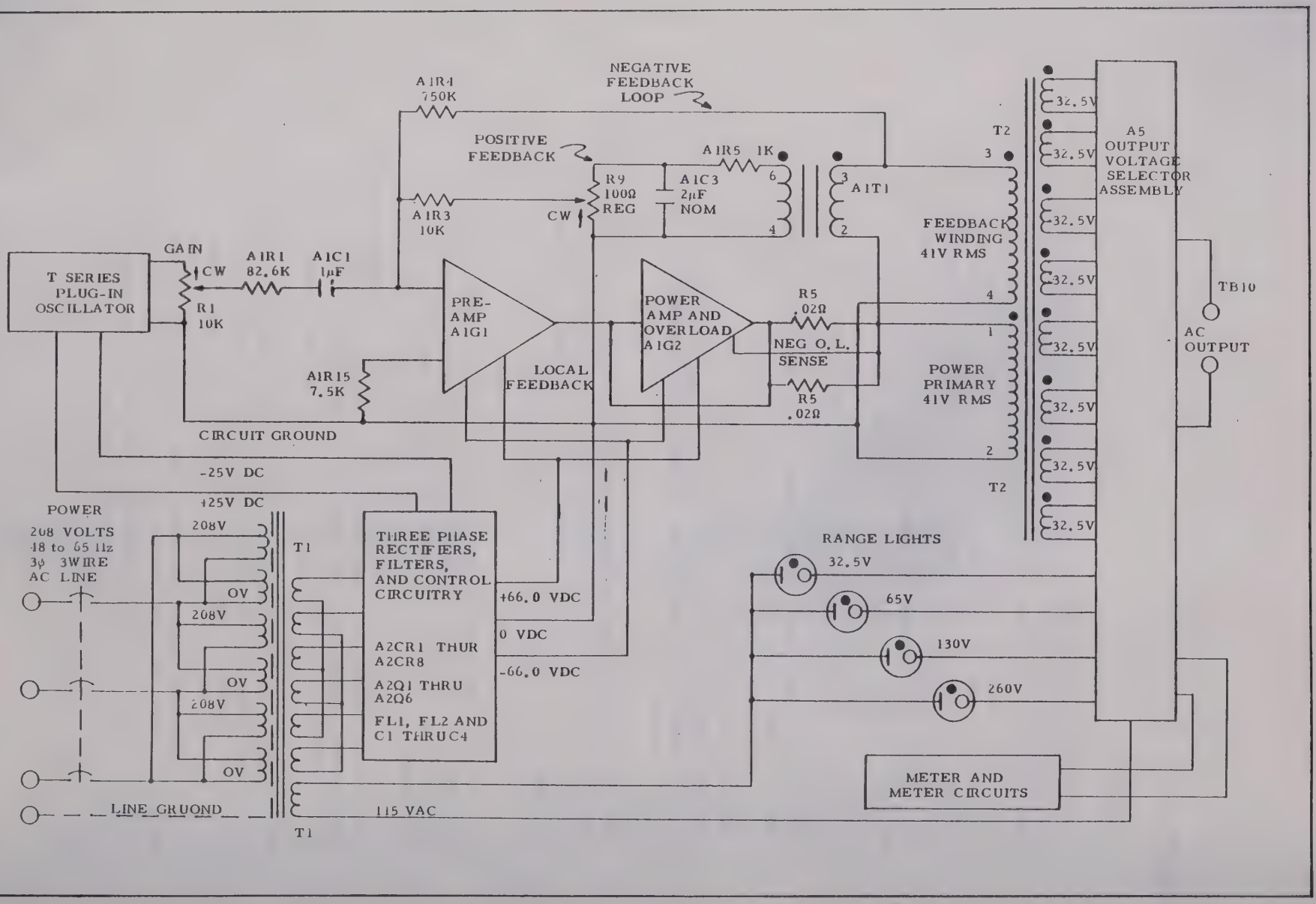


FIGURE 3-1 BLOCK DIAGRAM FOR 3001TC POWER SOURCE

Power transformer T1, along with the associated silicon controlled rectifiers, filters, and control circuitry provide a regulated +66 volts and a regulated -66 volts, each at currents up to 41 amperes DC. This power supply is used to provide the operating voltages for the plug-in oscillator, the pre-amplifier A1G1, and the output amplifier A1G2.

3.2 DETAILED CIRCUIT DESCRIPTION

A schematic diagram for the Model 3001TC Power Source is shown in Drawing E4250-091, with the exception of the circuitry contained on the pre-amplifier and control circuit board (assembly A1), the meter board (assembly A6), the output voltage range selector board (assembly A5), and the plug-in oscillator. A schematic for the pre-amplifier and control circuit board is given in Drawing E4250-092, and a schematic for the meter circuit is given in Drawing B4050-072. A schematic for the range selector board is given in Drawing D4250-079, and a schematic for the delay start assembly is 4500-713-1. For information on the plug-in oscillator, consult the applicable oscillator manual. These drawings give typical voltage levels and waveforms for the various sections of the power source.

3.2.1 PRE-AMPLIFIER

The pre-amplifier A1G1 is a part of the A1 assembly and consists of transistors A1Q1 through A1Q3 and associated components connected as a direct coupled differential amplifier. The open loop gain of this pre-amplifier is approximately 43 at 400 Hz and rolls off at 6 dB per octave from 460 Hz to 9.6 KHz; additional high frequency roll-off starts at approximately 20 KHz.

Transistor A1Q1 contains five transistors in one package, three npn devices, and two pnp devices. Transistors A1Q1A and A1Q1B are connected so as to form a differential amplifier whose voltage gain is approximately 40 at 400 Hz. Capacitor A1C7 and resistor A1R11 provide a high frequency step roll-off from 460 Hz to 9.6 KHz. Potentiometer A1R13 is used to adjust the DC bias at the power primary of T2 to zero volts with no signal. Transistor A1Q1C and resistor A1R16 are connected so as to provide a current of approximately 2.0 milliamperes to A1Q1A and A1Q1B.

Transistors A1Q1D and A1Q1E are connected so as to form a differential amplifier whose voltage gain is approximately 1.0. Their primary function is to act as level shifters and to provide a phase inversion.

Transistors A1Q2 and A1Q3 are connected so as to form a differential amplifier whose voltage gain is approximately 2.0. The output of A1Q3 is used to drive transistor A1Q4.

3.2.2 POWER AMPLIFIER

The power amplifier consists of transistors A1Q4 through A1Q9 located on the A1 assembly, transistors A3Q1 through A3Q23 located on the A3 heatsink assembly, and transistors A4Q1 through A4Q23 located on the A4 heatsink assembly.

Transistor A1Q4, resistors A1R29, A1R32, A1434, and diodes A1CR3, A1CR4 and A1CR5 are used to provide DC bias for the power output stage. This allows the output stage to operate as a Class A amplifier for no load or low VA load conditions and to operate nearly as a Class B amplifier for large load conditions.

Transistors A1Q4 and associated components are connected in the grounded emitter configuration. Local negative feedback is provided by A1C8, A1C12, and A1R28. The local feedbacks limit the gain of this stage to 80 at 400 Hz. The gain falls off at 6 dB per octave from 950 Hz.

The positive polarity output amplifier is contained on the A3 assembly and consists of A3Q1 through A3Q23 connected as emitter followers. These transistors supply a total of 127 amperes peak during the positive one-half cycle of the output waveform when the power source is loaded to 3000 VA output at 84.6 percent of rated output voltage (worst case condition within specification limits). These positive output amplifier transistors and their associated heatsinks can dissipate over 1650 watts with less than a 75°C case temperature rise with an air flow of 120 cfm per heatsink assembly.

The negative polarity output amplifier is contained on the A4 assembly and consists of A4Q1 through A4Q23 connected in the quasi-complementary symmetry configuration. These transistors supply a total of 127 amperes peak during the negative one-half cycle of the output waveform when the power source is loaded to 3000 VA output at 84.6 percent of rated output voltage (worst case condition within specification limits). These negative output amplifier transistors and their associated heatsinks can dissipate over 1650 watts with less than a 75°C case temperature rise with an air flow of 120 cfm per heatsink assembly.

When the power source is delivering its full rated output voltage, the primary of the output transformer has a 41.0 volt rms signal.

3.2.3 OVERLOAD PROTECTION

The overload protection circuitry is shown in Drawing E4250-092 and consists of A1Q5, A1Q6 and associated components.

Transistor A1Q5 and associated components are connected as a clamp circuit which is used to protect the positive polarity output amplifier (assembly A3) during periods of overload or short circuit. This is accomplished by sensing the voltage at the base of A3Q3 and applying it to the emitter-base junction of A1Q5 through a suitable attenuator network. During periods of overload, the emitter-base junction of A1Q5 is forward biased sufficiently to allow the

collector circuit of A1Q5 to conduct a significant portion of the base drive normally available to A1Q7. This, in turn, limits the base drive to A3Q1 and hence limits the available current from the positive polarity output amplifier during periods of overload. Potentiometer A1R48 is used to set the current level where the overload protection circuit is activated.

Transistor A1Q6 and associated components are used in a similar fashion to protect the negative polarity output amplifier (assembly A4). The only differences are that the control voltage for A1Q6 is sensed across A4R24 and potentiometer A1R46 is used to set the overload current level.

The rated VA output of the power source is, to a large extent, determined by the power dissipation in the quasi-complementary symmetry output stage. This power dissipation is determined by the power factor of the load, the output VA level of the amplifier, and to the actual output voltage expressed as a percentage of the rated output voltage. The derating chart, given in the specifications, expresses this derating in a graphical form.

The design of the overload circuitry is such that the overload level is determined by the same three parameters that determine the power dissipation in the Class B output stage. Resistors A1R38, A1R41, A1R42, A1R43, A1R44, and A1R45 have been selected so that the overload protection circuit and the power factor derating chart track one another quite closely in the region between 0 volts output and 84.6 percent of rated output voltage. In the region between 84.6 percent of rated output voltage and 100 percent of rated output voltage, the rated VA output of the power source is limited by an arbitrary rating and, as a result, the overload circuit allows a somewhat greater power output than that specified for the power source. The unit will be reliable in this mode of operation; however, output distortion and/or other specifications may be excessive.

3.2.4 EXCESSIVE LOAD INDICATOR LAMP

The front panel excessive load indicator lamp is activated by transistor A1Q9 and associated components. The emitter-base junction of A1Q9 is driven from the voltage developed at the base of A3Q3 through a suitable attenuator network. Potentiometer A1R55 is adjusted at the factory so that the excessive load lamp DS2 is activated at the same time that the overload protection transistors A1Q5 and A1Q6 are activated.

3.2.5 OVERALL NEGATIVE FEEDBACK

The overall negative feedback loop is a single-ended operational feedback loop taken from the negative feedback winding of T2 back to the base of A1Q1A. The feedback network consists of A1R3 and A1R4 and limits the mid-band closed loop voltage gain of the amplifier to 9.1 from the input side of A1R1 to the primary T2.

The purpose of this feedback loop is to insure that the frequency response, distortion, gain and amplitude stability specifications are met and/or exceeded.

A low frequency negative feedback loop is taken from the power primary winding of T2 back to the base of A1Q1A via A1R116 and A1R117. This loop limits the closed loop voltage gain of the amplifier to 3.0 at DC and thereby provides improved DC bias stability for the amplifier.

3.2.6 POSITIVE CURRENT FEEDBACK

The positive current feedback loop generates a positive feedback voltage proportional to the load current in the secondary of T2. This is accomplished in the following fashion:

The load current in the secondary of the output transformer T2 is reflected back into the power primary winding. The negative feedback winding is connected so as to buck out the $L\frac{di}{dt}$ drop in the power primary winding. The remaining differential signal is applied to the primary transformer A1T1 and converted into a single-ended signal at the secondary of A1T1. This signal is then applied to the base of A1Q1A through a divider network consisting of A1R3, A1R5, R9 and A1C3. Potentiometer R9, which is accessible from the front panel of the unit, is used to adjust the amount of positive feedback and thereby adjust the output impedance of the power source.

3.2.7 DC POWER SUPPLY

The DC Power Supply output voltage is regulated by means of the phase controlled SCR regulator shown in Drawing E4250-091. The positive supply consists of diodes A2CR1, A2CR2, A2CR3, A2CR4, and silicon controlled rectifiers A2Q1, A2Q2, A2Q3, and filter reactor FL1 and filter capacitors C1 and C3. This supply provides +66.0 volts $\pm$2 percent across capacitors C1 and C3 at currents up to 41 amperes DC for a $\pm$10 percent variation in the magnitude of the three phase incoming line. The ripple on the output of the +66 volt supply varies from 1.5 volts peak-to-peak to 9.0 volts peak-to-peak at full power output depending on the frequency of the output power in relation to the frequency of the incoming AC line. If, for example, the system output frequency is 1000 Hz and the incoming line frequency is 60 Hz, then the power supply ripple will be in the order of 1.5 volt peak-to-peak at six times the line frequency, or in this case, 360 Hz. If the system output frequency is 45 Hz and the incoming line frequency is 60 Hz, then the power supply ripple will be in the order of 9.0 volts peak-to-peak and primarily at the system output frequency or, in this case, 45 Hz.

Ripple at twice the incoming line frequency can be generated if the line-to-line voltages provided to the input of the power transfromer T1 are not all equal to one another.

The negative supply provides -66.0 volts ±2 percent across capacitors C2 and C4 at current up to 41 amperes DC for a ±10 percent variation in the magnitude of the incoming AC line. The ripple magnitude and ripple frequency are similar to that previously described for the positive DC power supply.

The control signals for driving the gates of the SCR's are provided by the pre-amplifier and control board, assembly A1.

3.2.8 POWER SUPPLY CONTROL CIRCUIT

The power supply control circuit is used to drive the phase controlled SCR's located on the A2 assembly. A schematic for the control circuit is given in Drawing E4250-092 and consists of integrated circuits A1IC1 through A1IC17, pulse coupling transformers A1T2 through A1T7, and associated components.

The operation of the +66 volt control circuitry is described below:

a) Integrated circuits A1IC2, A1IC3, and A1IC4 are used to generate square wave signals whose zero crossings coincide with those of the phase A, phase B and phase C voltages available at the secondary of transformer T1. The negative going edges of these square wave signals are used to trigger integrated circuits A1IC5 through A1IC10 via RC differentiating networks.

b) Integrated circuits A1IC5, A1IC6, and A1IC7 are each connected so as to form pulse width modulators. These pulse width modulators provide a positive polarity pulse output, at pin 3, upon receipt of the negative polarity trigger pulse. The width of these pulses is modulated by the voltage available at pin 6 of the error integrator A1IC1. When the output voltage of the error integrator becomes more positive, then the width of the pulse increases which, in turn, delays the trigger pulse to the drivers A1IC11, A1IC12, and A1IC13. The delay time can be varied from approximately 0.30 millisecond to 7.5 milliseconds with the pulse width modulator.

c) Integrated circuits A1IC11, A1IC12 and A1IC13 provide the power required to drive SCR's A2Q1, A2Q2, and A2Q3 respectively, via coupling transformers A1T2, A1T3, and A1T4. The output pulses, available at pin 3 of A1IC11, A1IC12 and A1IC13, are each approximately 40 microseconds wide and have a magnitude of 14 volts.

d) The DC reference voltage for the error integrator is provided by resistors A1R65, A1R66, A1R67, and the +15.0 volt supply. Capacitor A1C19 is used to delay the reference voltage to the error integrator with initial application of DC power to the A1 assembly.

Capacitor A1C19 also delays DC power to pin 4 of the drivers A1IC11, A1IC12, and A1IC13 with initial application of DC power to the A1 assembly. This, in turn, inhibits the drivers for approximately 100 milliseconds and allows transients to settle before SCR A2Q1, A2Q2, and A2Q3 are allowed to fire.

e) The +15.0 volt supply is provided by diodes A1CR10, A1CR11, and A1CR22, along with capacitor A1C45 and integrated circuit regulator A1IC18. This supply develops rated output voltage immediately when power is first applied to the Model 3001TC and supplies the required power to operate the SCR drive circuitry.

f) The thermal overload switches, mounted on the A3 and A4 assemblies, are closed at a heatsink temperature of approximately 105°C. This drives pin 4 of A1IC11 through A1IC16 to zero volts, which inhibits all drive pulses to the SCR's. When the heatsink temperature drops below approximately 90°C, the thermal overload switch opens, allowing A1C19 to charge back to its nominal value of 9.0 volts. This allows the +66 and -66 volt supplies to return to their nominal values in a "soft" fashion.

g) The output of the +66 volt supply is divided through resistors A1R62 and A1R64 and then applied to the noninverting input of the error integrator via potentiometer A1R63. Potentiometer A1R63 is used to set the output voltage of the +66 volt supply to exactly +66 volts $\pm$0.1 volt DC.

The operation of the -66 volt supply is similar to that of the +66 volt supply except the output voltage is adjusted to -66 volts $\pm$0.1 volt DC with potentiometer A1R101.

3.2.9 FRONT PANEL METER

The front panel meter M1 has a full scale sensitivity of 0 to 1 milliampere DC and an internal resistance of approximately 100 ohms. The meter has four scales with full scale ranges of 0 to 40 volts AC, 0 to 80 volts AC, 0 to 160 volts AC, and 0 to 320 volts AC. The meter rectifiers and scaling circuitry are mounted on the rear of the meter.

The meter circuitry is designated as the A6 assembly and is shown in Drawing B4050-072. This circuitry consists of rectifier diodes A6CR1 through A6CR4, potentiometer A6R1 and associated components. The four rectifier diodes are connected so as to form a full wave bridge rectifier. Potentiometer A6R1 is used to shunt a small portion of the meter current and provide a sensitivity adjustment on the 40 volt scale. Resistors A6R3, A6R4, and A6R5 are selected at the factory to provide proper tracking on the 320 volt, 160 volt, and 80 volt ranges, respectively.

The meter range is automatically switched with the rotation of the rear loaded range assembly. The 40 volt full scale range of the meter is used with the 0-32.5 volt range of the power source; the 80 volts full scale range of the meter is used with the 0 to 65 volt range of the power source; the 160 volt full scale range of the meter is used with the 0 to 130 volt range of the power source; and the 320 volt full scale range of the meter is used with the 0 to 260 volt range of the power source.

3.2.10 OUTPUT VOLTAGE RANGE

The output voltage range is controlled by the rotation of printed circuit board assembly A5. A schematic for this printed circuit board is shown in Drawing D4250-079. The primary purpose of this printed circuit board is to interconnect the multiple secondary windings of T2 in various fashions depending on the desired output voltage range. Table 3-1 below illustrates this interconnection.

OUTPUT VOLTAGE RANGE	INTERCONNECTION
0 to 32.5 volts rms	S1, S2, S3, S4, S5, S6, S7, and S8 are all connected in parallel to provide the 0 to 32.5 volt output.
0 to 65 volts rms	S1, S2, S5, and S6 are connected in parallel; S3, S4, S7, and S8 are connected in parallel. These two combinations are connected together in the series aiding configuration to provide the 0 to 65 volt output.
0 to 130 volts rms	S2 is in parallel with S1; S4 is in parallel with S3; S6 is in parallel with S5; S8 is in parallel with S7. S1, S3, S5, and S7 are connected in the series aiding configuration to provide the 0 to 130 volt output.
0 to 260 volts rms	S1, S2, S3, S4, S5, S6, S7, and S8 are connected in the series aiding configuration to provide the 0 to 260 volt output.

TABLE 3-1

3.2.11 DELAY START

The delay start assembly A107 provides for a short delay in connecting the base drives to the output stages during turn-on. The delay allows the power supplies to establish regulation and thus avoid potentially damaging transients.

Drive to the output stages is removed when input power is interrupted. This avoids the transients caused by unequal decay of the power supplies.

When power is first applied, Relay A107-K1 is energized, applying the positive power supply to R-C network of A107-R2 and A107-C1. The charging of A107-C1 provides approximately five seconds delay before transistor A107-Q1 is turned on. When A107-Q1 is on, A107-K2 is energized, providing drive to the output stages.

Drive will be removed under two conditions. If input power is interrupted, A107-K1 will de-energize, thus grounding the base of A107-Q1, turning A107-Q1 off, de-energizing A107-K2. Drive will also be removed if the thermal overload is activated. Thermal overload shuts down the power supply, removing drive for Relay A107-K2.

WARNING

Voltages up to 480 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with pin C and pin D of the plug-in oscillator, the primary power circuits, and the output circuits of the power source.

CALIBRATION PROCEDURE

4.1 GENERAL

The following calibration procedure, or any part of it, may be performed on a routine basis to insure that the Model 3001TC Power Source remains within specified tolerances. This procedure should always be performed after any repairs have been made to the unit. Figure 4-2 shows the location of internal test points and adjustment potentiometers. This procedure also covers test methods for the following power source adjustments and specifications:

a) Initial Adjustments

b) Regulated Power Supply Adjustments

c) Overload Adjustment

d) Harmonic Distortion

e) AC Line Input Current

f) Line Regulation

g) Load Regulation Adjustment

h) Amplitude Stability

i) Frequency Response

j) AC Noise Level

k) 0.7 Lagging Power Factor

l) 0.7 Leading Power Factor

This calibration procedure assumes that the power source will be operated from the 208 volt 48 to 65 Hz three phase, three wire AC line. For 370 volts or higher values of AC line voltage, a 480 volt variac must be substituted for that called out in this procedure. Consult Section 2.2.1 of this instruction manual for operation from other than the 208 volt AC line.

This calibration procedure further assumes that the power source is tested on the 0 to 130 volt range. Performance is very similar on the other three ranges. The table on the following page illustrates the change in measurement voltage and impedance level when evaluating the power source on various output voltage ranges.

RATED OUTPUT VOLTAGE	32.5 VAC	65 VAC	130 VAC	260 VAC
84.6% of Rated Output Voltage	27.5 VAC	55.0 VAC	110 VAC	220 VAC
Resistance Load for 3000 VA Output at Rated Output Voltage	0.352Ω	1.41Ω	5.63Ω	22.53Ω
Resistance Load for 3000 VA Output in 84.6% of Rated Output	0.252Ω	1.008Ω	4.03Ω	16.13Ω

TABLE 4-1

Section 2.4 of this instruction manual indicates the procedure required to change output voltage ranges, and Section 2.8 indicates some potential problems associated with output wiring IR drop on the low voltage ranges. When checking load regulation and amplitude stability, care should be taken to use a four-wire connection such that the external load and the measurement equipment have completely separate wiring from the large AC output terminal strip located at the rear of the power source.

4.2 TEST EQUIPMENT REQUIRED

The following test equipment is required to perform the calibration procedure assuming that the three phase input line voltage has a nominal value of 208 volts L-L and that the power source is tested on the 0-130 volt range. Some equipment substitutions will be required if this is not the case.

a) Oscilloscope, Tektronix 533A with "W" plug-in.

b) 15KVA Variac, General Radio 3XW50M or equivalent.

c) True Rms voltmeter, H. P. 3400A or equivalent.

d) Three 0.1 ohm ±1% 50 watt resistors, Dale Type.

e) Distortion Analyzer, H. P. 334A or equivalent.

f) Differential Voltmeter, Fluke 883A or equivalent.

g) Multi-range 3000 watt load box, or individual 3000 watt power resistors, as defined in Table 4-1. Dale Type NHL or equivalent.

h) Expanded Scale (about 115 VAC) strip chart recorder, Voltron Model 89.038 or equivalent.

i) Multimeter, Simpson 260 or equivalent.

4.3 INITIAL ADJUSTMENTS

4.3.1 Connect the Model 3001TC Power Source as shown in Figure 4-1. Turn the GAIN control fully counter-clockwise. Adjust the line voltage to its nominal value with the three phase variac. Turn the POWER switch "on." The line current meters should each indicate 2.0 amperes (0.20 volt across 0.1 ohm) or less at nominal line voltage when operating from the 60 Hz AC line and 4.0 amperes or less when operating from the 50 Hz AC line. If a problem is encountered, perform Step 4.3.2 below.

4.3.2 Remove the top cover from the unit, and check the -66 volt supply by connecting the differential voltmeter from A1TP6 (high side) to A1TP1 (common). Adjust potentiometer A1R101 if the -66 volt supply is not -66 volts $\pm$0.5 volt. The -66 volt supply should be adjusted first as there is an interaction with the +66 volt supply.

Check the +66 volt supply by connecting the differential voltmeter from A1TP5 (high side) to A1TP1 (common). Adjust potentiometer A1R63 if the +66 volt supply is not +66 volts $\pm$0.5 volt.

Connect the differential voltmeter between test points A1TP4 and A1TP1. Adjust the potentiometer A1R13 so that the DC voltage across the primary of the output transformer T2 is 0.00 volts $\pm$5 millivolts DC. This balances and minimizes the collector current in both halves of the output stage.

4.3.3 Connect the differential voltmeter to the power output terminals at the rear of the unit, and select the 0 to 32.5 volt range with the rear loaded printed circuit assembly. Adjust the GAIN control for a 32.5 volt output with the oscillator set to 400 Hz. Adjust the meter calibration control A6R1 so that the front panel meter and the differential voltmeter correlate within one percent of each other. Vary the frequency from 45 Hz to 2 KHz, and check that the front panel meter reads within $\pm$3 percent of the correct value.

4.3.4 Remove power from the unit, and select the 0 to 65 volt range with the rear loaded printed circuit assembly. Set the oscillator to 400 Hz, and adjust the output to exactly 65 volts while reading the differential voltmeter. Select resistor A6R5 so that the front panel meter and the differential voltmeter correlate within one percent. Vary the frequency from 45 Hz to 2 KHz, and check that the front panel meter reads within $\pm$3 percent of the correct value.

4.3.5 Remove power from the unit and select the 0 to 130 volt range with the rear loaded printed circuit assembly. Set the oscillator to 400 Hz, and adjust the output to exactly 130 volts while reading the differential voltmeter. Select resistor A6R4 so that the front panel meter and the differential voltmeter correlate within one percent. Vary the frequency from 45 Hz to 2 KHz, and check that the front panel meter reads within $\pm$3 percent of the correct value.

4.3.6 Remove power from the unit, and select the 0 to 260 volt range with the rear loaded printed circuit assembly. Set the oscillator to 400 Hz, and adjust the output to exactly 260 volts while reading

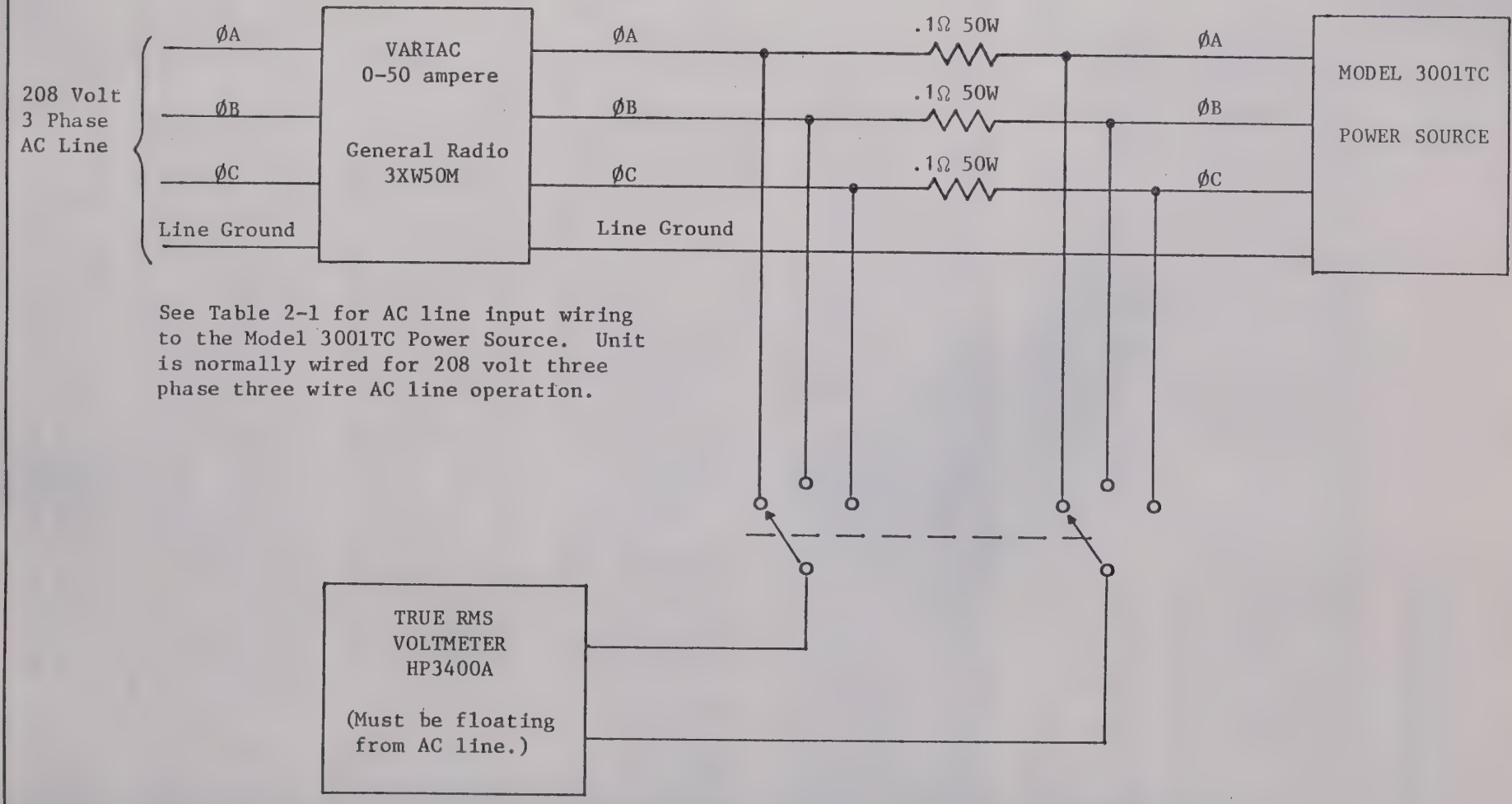


FIGURE 4-1 TEST CIRCUIT FOR INITIAL ADJUSTMENT OF MODEL 3001TC POWER SOURCE

the differential voltmeter. Select resistor A6R3 so that the front panel meter and the differential voltmeter correlate within one percent. Vary the frequency from 45 Hz to 2 KHz, and check that the front panel meter reads within ±3 percent of the correct value.

4.4 REGULATED POWER SUPPLY ADJUSTMENT AND TEST PROCEDURE

4.4.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Select the 130 volt range, and adjust the output voltage of the power source so as to provide 110 volts rms (84.6 percent of rated output voltage) at 400 Hz. Close switch S2 (4.03 ohm load) so that the power source is delivering 3000 VA to the external load. Set the three phase input voltage to its nominal value (208 volts L-L in this case).

4.4.2 Set the -66 volt supply to -66.0 volts ±0.10 volt with potentiometer A1R101 under full-load conditions as defined in Step 4.4.1 above.

4.4.3 Set the +66 volt supply to +66.0 volts ±0.10 volt with potentiometer A1R65 under full-load conditions as defined in Step 4.4.1 above.

4.4.4 Vary the three phase input line voltage from 187.2 volts L-L (-10 percent) to 228.8 volts L-L (+10 percent), and check that the +66 volt and -66 volt supplies each vary less than ±0.25 volt DC.

4.4.5 Open switch S2 so as to remove the full-power load, and then readjust the three phase line voltage to its nominal value (208 volts L-L) with the variac. Check that both the +66 volt and -66 volt DC supplies vary less than 0.25 volt DC from full-load operation to no-load operation.

4.5 OVERLOAD ADJUSTMENTS

4.5.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Select the 130 volt range, and adjust the output voltage of the power source to 110 volts rms (84.6 percent of rated output voltage) at 400 Hz. Close switch S2 (4.03 ohm load), and readjust the output voltage slightly, if required, in order to maintain a 110 volt output. The power source should deliver a clean sine wave output with less than 0.30 percent distortion. Vary the frequency from 45 Hz to 2 KHz, and check that the distortion does not exceed 0.50 percent at 2 KHz over the three phase AC input line voltage range of 187.2 volts to 228.8 volts (208 volts nominal input voltage). Adjust potentiometer A1R48 so that no clipping or excessive distortion occurs on the positive peak of the output waveform under worst case conditions outlined above. Adjust potentiometer A1R46 so that no clipping or excessive distortion occurs on the negative peak of the output waveform under worst case conditions outlined above. These two adjustments may interact somewhat so care should be taken not to move one adjustment excessively without checking the effect on the other adjustment.

4.5.2 Set the output of the power source to 110V rms at 400 Hz. Connect a 50 percent overload on the output of the power source, and check that there is significant clipping on both the positive and negative peaks of the output waveform. Adjust potentiometer A1R55 so that the EXCESSIVE LOAD lamp is lit to about one third of normal

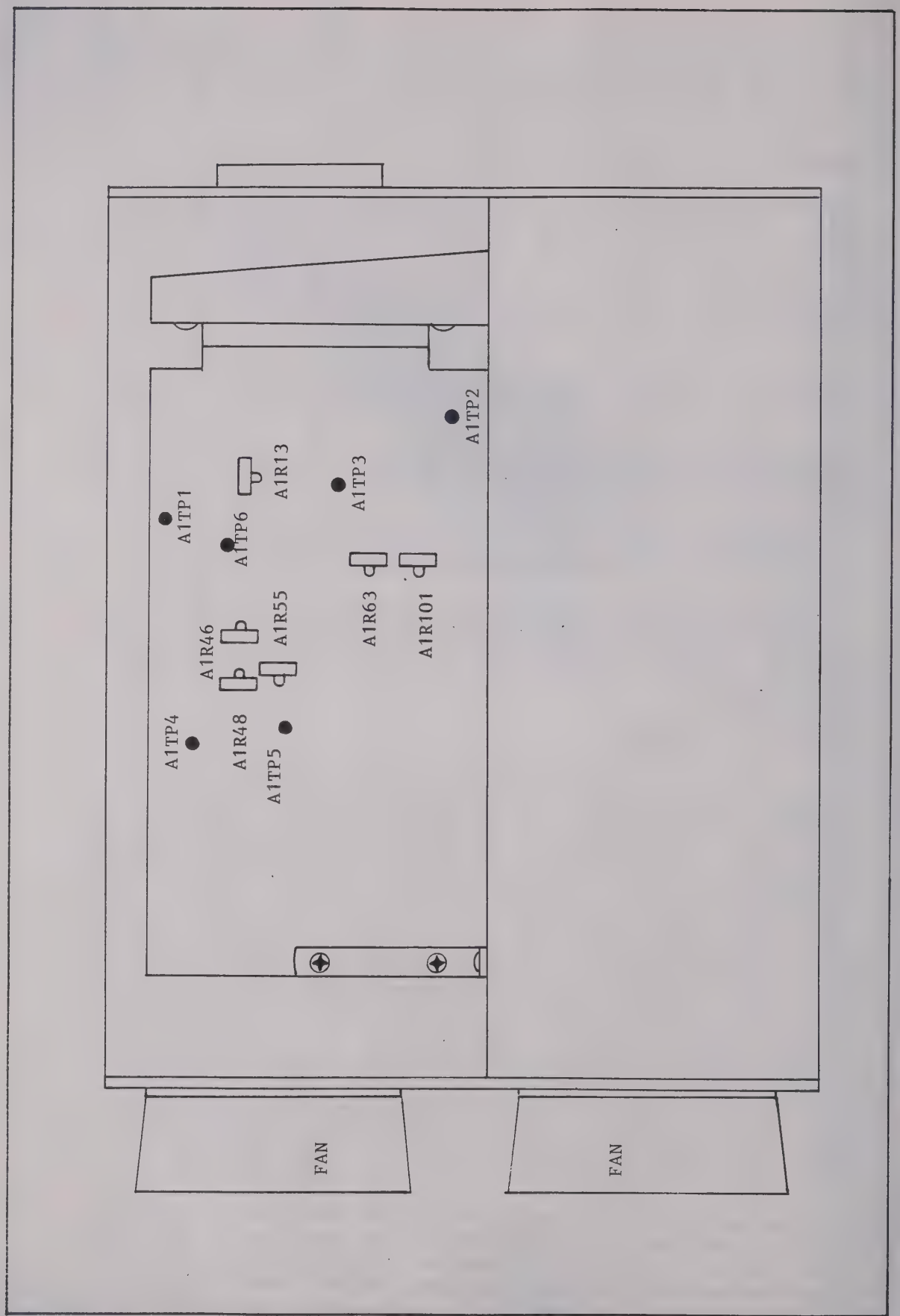


FIGURE 4-2

INTERNAL ADJUSTMENT FOR MODEL 3001TC POWER SOURCE

brightness with the 50 percent overload and is out with a normal 100 percent load. If the front panel circuit breaker is activated, reset the circuit breaker according to the procedure given in Step 2.5.6.

4.5.3 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit assembly should be rotated to provide the proper output voltage range. The load impedance and output voltage levels should be taken from those given in Table 4-1.

4.6 HARMONIC DISTORTION

4.6.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Select the 130 volt range with the rear loaded printed circuit assembly. Adjust the three phase input line voltage variac to provide a nominal input line voltage (208 volts L-L in this case). Set the oscillator output of the amplifier with the GAIN control to provide 130 volts rms (100% of rated output). Close switch S1 so that the 5.63 ohm load is across the output of the power source.

4.6.2 Vary the AC line voltage ±10 percent of nominal value with the three phase variac, and check that no significant clipping is observed on the sine wave output with the oscilloscope. The harmonic distortion must be less than 0.5 percent over the full line voltage range.

4.6.3 Set the oscillator output to 45 Hz, and adjust the output of the power source to 130 volts rms with the GAIN control. Repeat Step 4.6.2. The harmonic distortion must be less than 0.50 percent over the full line voltage range.

4.6.4 Set the oscillator output to 600 Hz, and adjust the output of the power source to 130 volts rms with the GAIN control. Repeat Step 4.6.2. The harmonic distortion must be less than 0.5 percent over the full line voltage range.

4.6.5 Set the oscillator output to 2 KHz, and adjust the output of the power source to 130 volts rms with the GAIN control. Repeat Step 4.6.2. The harmonic distortion must be less than 1.0 percent over the full line voltage range.

4.6.6 Repeat Steps 4.6.1 through 4.6.5 except set the output of the power source to 110 volts rms (84.6 percent of rated output), and close switch S2 instead of S1. The harmonic distortion must be less than 0.5 percent from 45 Hz to 600 Hz and less than 1.0 percent from 600 Hz to 2 KHz.

4.6.7 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit assembly should be rotated to provide the proper output voltage range. The load impedance and output voltage levels should be taken from those given in Table 4-1.

4.7 AC LINE INPUT CURRENT

4.7.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Select the 130 volt AC range according to the procedure given in Section 2.4 of this instruction manual.

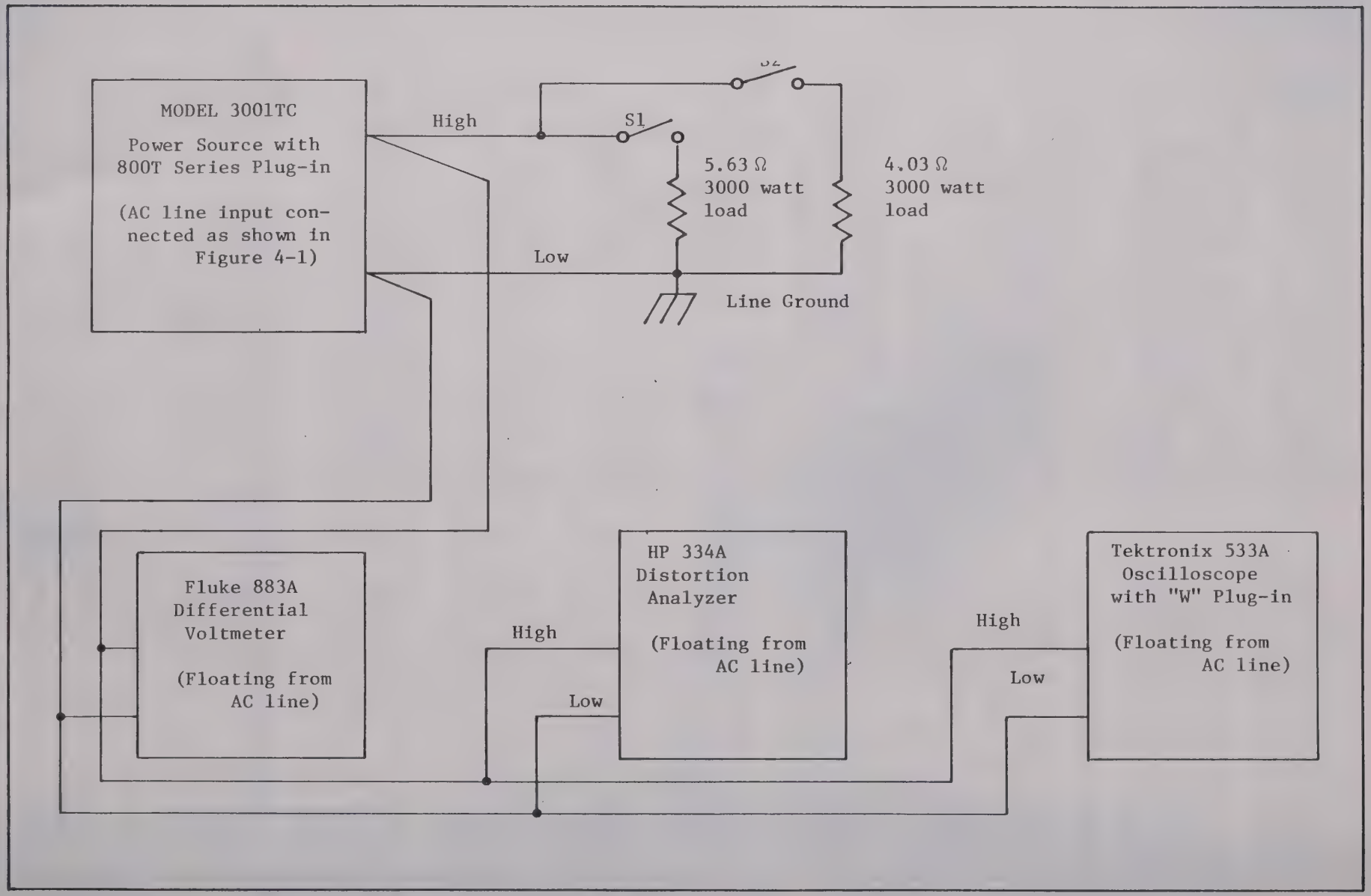


FIGURE 4-3 TEST CIRCUIT FOR MODEL 3001TC POWER SOURCE

4.7.2 Adjust the GAIN control on the power source to provide an output of 110 volts rms at 400 Hz with switch S2 closed so as to apply full load to the output of the power source. With the three phase AC input line voltage adjusted to its maximum value (228.8 volts AC on 208 volt range), the average AC input line rms current should be less than 24 amperes, and all three readings should be within 20 percent of the average line current when operating from the 60 Hz AC line. The average AC input line rms current should be less than 25 amperes when operating from the 50 Hz AC line.

4.7.3 Repeat Step 4.7.2 except open switch S2 so that there is no load on the output of the power source. The average AC input rms line should be less than 2.0 amperes, and all three readings should be within 50 percent of the average line current when operating from the 60 Hz AC line. The average AC input rms line current should be less than 4.5 amperes, and all three readings should be within 50 percent of the average line current when operating from the 50 Hz AC line.

4.7.4 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit assembly should be rotated to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1.

4.8 LINE REGULATION

4.8.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Select the 130 volt range according to the procedure given in Section 2.4 of this instruction manual. Adjust the variac to provide a 208 volt three phase AC line input. Set the oscillator frequency to 400 Hz, and adjust the GAIN control to provide a 130 volt rms output (100 percent of rated output voltage) with switch S1 closed to that a 5.63 ohm load is across the output of the power source.

4.8.2 Vary the AC input L-L voltage from 187.2 volts to 228.8 volts AC, and measure the change in output voltage of the power source. This change should be less than 0.26 volts rms.

4.8.3 Set the oscillator frequency to 2 KHz, and adjust the amplitude control to provide a 130 volt L-N output; repeat Step 4.8.2. The change in output voltage should be less than 0.26 volts rms.

4.8.4 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit assembly should be rotated to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1.

4.9 LOAD REGULATION ADJUSTMENT

The load regulation adjustment is accessible from the front panel of the power source and is usually adjusted for zero regulation at 400 Hz. This adjustment is somewhat sensitive to the output voltage range and should be readjusted whenever the output voltage range is changed.

4.9.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Check that the load is connected to the large AC output terminals TB10 at the rear of the power source. The output voltage may be monitored either at the rear or the front of the power source. If it is monitored at the rear of the power source, care should be taken to use four-wire sensing. Adjust the output voltage of the Model 3001TC Power Source to 110 rms output (84.6 percent of rated output voltage) at 400 Hz.

4.9.2 Place the differential voltmeter on the 1000 volt AC range, and connect it across the front panel output terminals of the power source. Adjust R9 (accessible from the front panel of the power source and labeled REG) so that the output voltage variation is less than 20 millivolts as the 4.03 ohm load is added and removed. Maintain the line voltage at nominal value during this test.

4.9.3 Set the frequency of the oscillator to 2 KHz. Adjust the output amplitude of the power source to 110 volts rms with no load on the output of the power source. The output of the power source should change less than $\pm$1.10 volts rms when loaded with the 4.03 ohm resistor. Maintain the line voltage at nominal value during this test. Capacitor A1C4, in the secondary circuit of A1T1, has been set at the factory for optimum load regulation at 2 KHz and may be changed if required.

4.9.4 Set the frequency of the oscillator to 45 Hz, and repeat Step 4.9.3. The output of the power source should change less than 1.10 volt rms.

4.9.5 This procedure (Steps 4.9.1 through 4.9.4) may be performed for any of the other output voltage ranges, rather than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit assembly should be rotated to provide the proper output voltage range. The load impedance and output voltage levels should be taken from those given in Table 4-1. Care should be taken to use non-inductive load resistors, especially on the 32.5 volt and 65 volt output voltage ranges where load impedances are very low and a few microhenries of inductance will significantly influence the power factor at 2 KHz. The load regulation must remain within a $\pm$1 percent band from 45 Hz to 1 KHz and within a $\pm$2 percent band from 45 Hz to 2 KHz on the 65 volt and 260 volt output ranges. The load regulation must remain within a $\pm$1 percent band from 45 Hz to 1.0 KHz and within a $\pm$3 percent band from 45 Hz to 2 KHz on the 32.5 volt range.

NOTE

Care should be taken to insure that the output amplitude of the oscillator remains stable and independent of load conditions during this test.

4.10 AMPLITUDE STABILITY

4.10.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Adjust the three phase AC input line voltage to 208 volts L-L. Adjust the output of the power source to provide a 115 volts rms output (88.5 percent of rated output voltage) at 400 Hz. Connect a 4.41 ohm (3000 VA) load to the output terminals at the rear of the power source, and check that the REG control has been set to provide a zero output impedance.

4.10.2 Connect an AC expanded scale (about 115 volts rms) strip chart recorder across the output terminals of the power source, and record the drift during a 24-hour period. This drift should be less than $\pm$0.29 volts rms. Disregard the drift during the first hour as this represents initial warm-up drift. Care should be taken to insure that the ambient temperature is held constant at $\pm$3 degrees centigrade for this test.

4.10.3 This procedure may be performed for any of the other output voltage ranges, rather than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit assembly should be rotated to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1 consistent with the dynamic range of the specific expanded scale strip chart recorder employed for the test.

4.11 FREQUENCY RESPONSE

4.11.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Adjust the three phase input AC line voltage to 208 volts L-L. Adjust the output of the power source to provide 130 volts rms (100 percent of rated output voltage) at 400 Hz.

4.11.2 Vary the output frequency of the oscillator from 45 Hz to 2 KHz, and monitor the output voltage of the power source with a differential voltmeter under no-load conditions. The output of the power source should vary less than $\pm$7.7 volts rms from 45 Hz to 2 KHz.

4.11.3 Close switch S1, and repeat Steps 4.11.1 and 4.11.2. The output of the power source should vary less than $\pm$7.7 volts rms from 45 Hz to 2 KHz.

4.11.4 This procedure may be performed for any of the other output voltage ranges, other than the 0 to 130 volt range, if desired. In this case, the rear loaded printed circuit assembly should be rotated to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1. The output must vary less than $\pm$0.5 dB from 45 Hz to 2 KHz.

4.12 AC NOISE LEVEL

4.12.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Adjust the three phase input line voltage to 208 volts L-L. Adjust the output of the power source to provide 110 volts rms (84.6 percent of rated output voltage) at 60 Hz.

4.12.2 Close switch S2, and monitor the output of the power source with the Tektronix 533A Oscilloscope with a "W" plug-in. Using the offset feature of the "W" plug-in, observe the positive peak of the output voltage at a vertical sensitivity of 0.5 volt per centimeter and sweep rate of 0.2 millisecond per centimeter using the oscilloscope in the LINE SYNC mode of operation. Rock the oscillator frequency slightly so that the peak value of the output wave form is displayed on the oscilloscope. The peak noise and ripple riding on the sine wave output should not exceed 0.492 volt (50 dB below full output). The noise and ripple output may be slightly greater if the power source is tested with the AC input line voltage somewhat above nominal value.

4.12.3 Steps 4.12.1 and 4.12.2 may be performed on any of the other output voltage ranges, if desired. In this case, the rear loaded printed circuit assembly should be rotated to provide the proper output voltage range. The load impedance and output voltage level should be taken from those given in Table 4-1. The chart below gives the acceptable noise level output on each voltage range.

Rated Output Voltage	32.5 VAC	65 VAC	130 VAC	260 VAC
Peak Noise Level with 3000 VA Load (See Step 4.12.2)	0.123V Peak	0.246V Peak	0.492V Peak	0.984V Peak

4.13 0.7 LAGGING POWER FACTOR

4.13.1 Connect the Model 3001TC Power Source as shown in Figure 4-3. Select the load circuit to correspond with the required output voltage range. Figure 4-4 illustrates the load circuit and gives load parameter values for 3000 VA 0.7 power factor at 400 Hz with 84.6 percent of rated output voltage from the power source. This represents the worst case inductive load for maximum power dissipation inside the power source.

4.13.2 Set the oscillator frequency to 400 Hz, and adjust the GAIN control for 84.6 percent of rated output voltage. Check that the power source produces a stable output with no high-frequency oscillation or excessive distortion. Refer to Section 4.6 of this instruction manual for the procedure to measure harmonic distortion. This distortion must be less than 0.30 percent at 400 Hz. The overload adjustments, A1R46 and A1R48, may have to be rotated counter-clockwise (when viewed from the front of the 3001TC) slightly with a 0.7 power factor load to meet the 0.5 percent distortion specification.

4.13.3 The REG control usually does not require significant readjustment in order to provide a zero regulation with a 0.7 power factor load at 400 Hz. If the unit is to be operated at a 0.7 power factor in the high frequency region, i.e., at 2 KHz, then it may be necessary to readjust the REG control. In this case, rotate the front panel REG control until zero regulation is obtained at the specific frequency and load condition.

4.13.4 The three phase AC line input current is 24 amperes per leg maximum with a 0.7 power factor load at 84.6 percent of rated output voltage and an input L-L voltage of 228.8 volts at 60 Hz (on 208 volt L-L range).

4.13.5 The above test may be repeated at frequencies other than 400 Hz provided the inductance of the series inductor is changed inversely proportional to the absolute value of the test frequency. For example, at 1 KHz, the inductance value must be divided by 2.5. The series resistance value remains unchanged.

4.14 0.7 LEADING POWER FACTOR

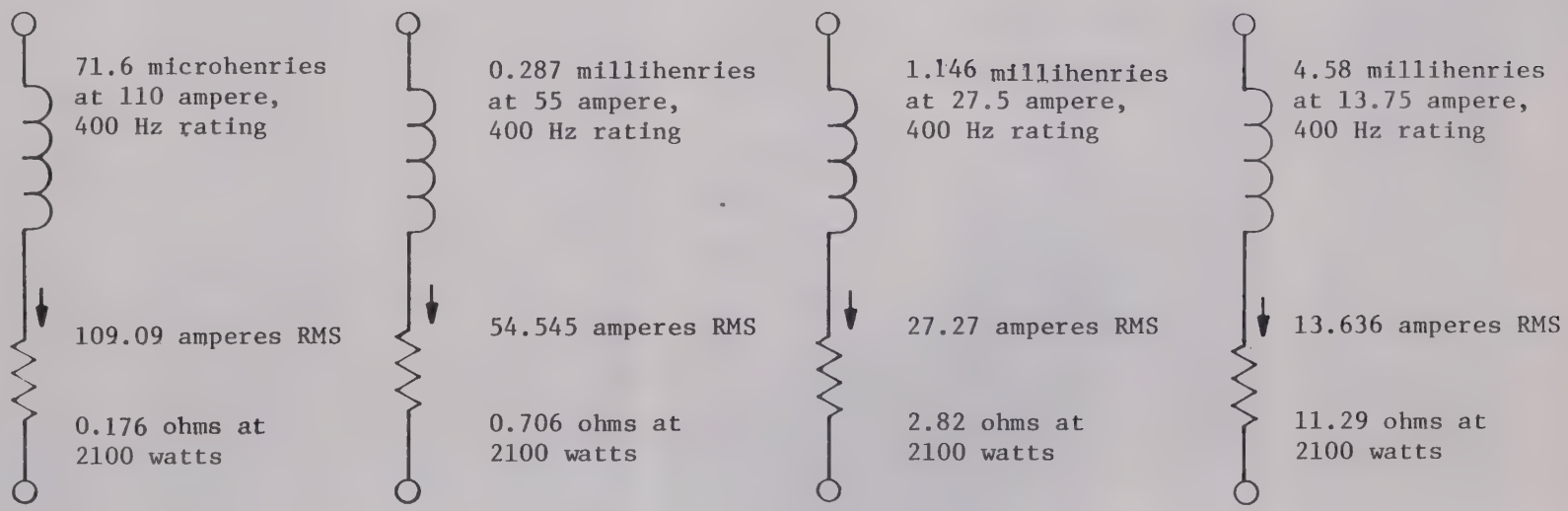
4.14.1 Connect the Model 3001TC Power Source as shown in Figure 4.3. Select the load circuit to correspond with the required output voltage range. Figure 4-5 illustrates the load circuit and gives load parameter values for 3000 VA 0.7 power factor operation at 400 Hz with 84.6 percent of rated output voltage from the power source. This represents the worst case capacitive load for maximum power dissipation inside the power source.

4.14.2 Set the oscillator frequency to 400 Hz, and adjust the GAIN control for 84.6 percent of rated output voltage. Check that the power source produces a stable output with no high frequency oscillation or excessive distortion. Refer to Section 4.6 for the procedure to measure harmonic distortion. This distortion must be less than 0.30 percent at 400 Hz. The overload adjustments, A1R46 and A1R48, may have to be rotated counter-clockwise (when viewed from the front of the 3001TC) slightly with a 0.7 power factor load to meet the 0.30 percent distortion specification.

4.14.3 The REG control usually does not require significant readjustment in order to provide a zero regulation with a 0.7 power factor load at 400 Hz. If the unit is to be operated at a 0.7 power factor in the high frequency region, i.e., at 2 KHz, then it may be necessary to readjust the REG control. In this case, rotate the front panel REG control until zero regulation is obtained at the specific frequency and load condition.

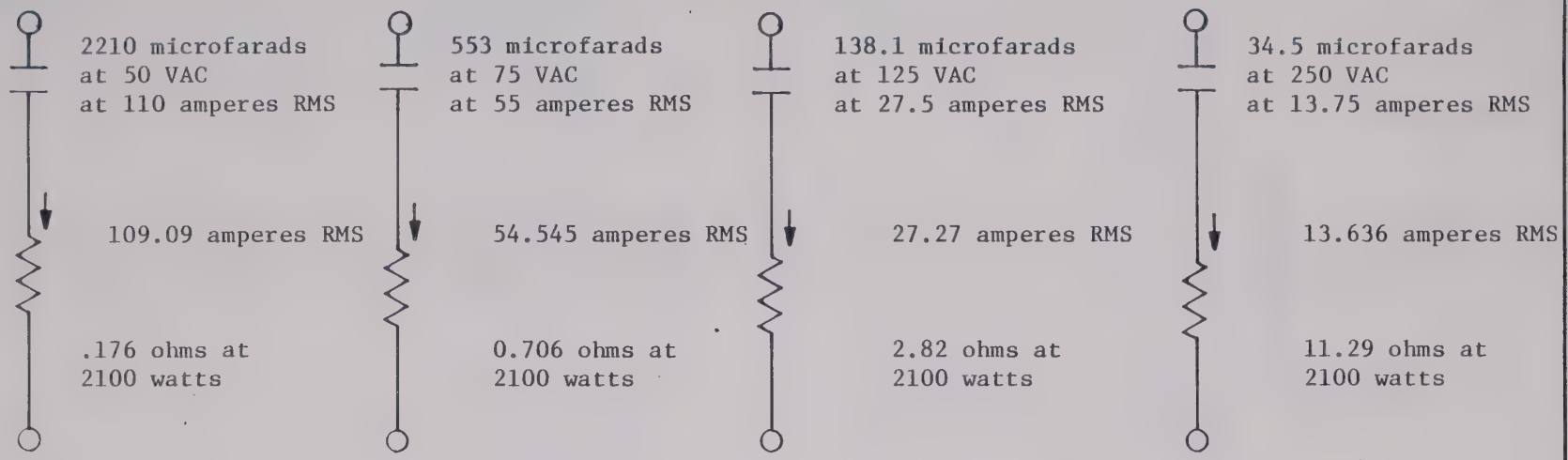
4.14.4 The three phase AC line rms input current is 24 amperes per leg maximum with a 0.7 power factor load at 84.6 percent of rated output voltage and an input L-L voltage of 228.8 volts at 60 Hz (on 208 volt L-L range).

4.14.5 The above test may be repeated at frequencies other than 400 Hz provided the capacitance of the series capacitor is changed inversely proportional to the absolute value of the test frequency. For example, at 1 KHz, the capacitance value must be divided by 2.5. The series resistance value remains unchanged.



0-32.5 VAC Range	0-65 VAC Range	0-130 VAC Range	0-260 VAC Range
3000 VA .7 pf load at 27.5 V RMS entire load.	3000 VA .7 pf load at 55.0 V RMS across entire load.	3000 VA .7 pf load at 110 V RMS across entire load.	3000 VA .7 pf load at 220 V RMS across entire load.

FIGURE 4-4
LOAD CIRCUIT FOR 0.7 LAGGING POWER FACTOR AT 400 Hz



0-32.5 VAC Range	0-65 VAC Range	0-130 VAC Range	0-260 VAC Range
3000 VA .7 pf load at 27.5 V RMS across entire load.	3000 VA .7 pf load at 55.0 V RMS across entire load.	3000 VA .7 pf load at 110 V RMS across entire load.	3000 VA .7 pf load at 220 V RMS across entire load.

FIGURE 4-5

LOAD CIRCUIT FOR 0.7 LEADING POWER FACTOR AT 400 Hz

WARNING

Voltages up to 480 VAC are available in certain sections of this power source. This equipment generates potentially lethal voltages.

DEATH

on contact may result if personnel fail to observe safety precautions. Do not touch electronic circuits when power is applied. Avoid contact with pin C and pin D of the plug-in oscillator, the primary power ciruits, and the output circuits of the power source.

MAINTENANCE AND TROUBLESHOOTING

5.1 GENERAL

The California Instruments Model 3001TC Power Source is a solid-state unit and should require a minimum of maintenance. However, it is forced air cooled and will accumulate some dust with time. The power transistor heatsinks should receive a forced air bath at intervals not to exceed six months.

CAUTION

> Failure to keep the heatsinks clean will reduce their thermal transfer efficiency somewhat and could cause failure of the power source.

5.2 TROUBLESHOOTING

5.2.1 If a problem appears in the power source, it must be isolated to a specific section of the unit. Before servicing the amplifier, check that the AC power input to the unit is of the proper amplitude and frequency. Check that the signal input to the power amplifier is also of the proper amplitude (approximately 5 volts rms) and frequency (45 Hz to 2 KHz). Check that the output load on the power amplifier is not excessive or that the load starting transients are not excessive. Check that the output of the oscillator is coupled to the input of the power amplifier through the 12-pin connector on the rear of the power amplifier.

5.2.2 If the circuit breaker is activated as soon as power is applied to the Model 3001TC, wait one minute and again try to reset the circuit breaker. If the circuit breaker will not properly reset, check that one or more of the power transistors are not shorted. Also check for a shorted SCR, a shorted rectifier diode or a shorted filter capacitor with an ohmmeter.

5.2.3 If the problem is in the regulated power supplies, disconnect the base drive to both A3Q1 and A4Q1 at the in-line splices. This will prevent possible damage to the output stage while troubleshooting the regulated power supplies. The $\pm$66 volt supplies should each exhibit less than 2 volts of overshoot when power is applied to the unit under high input line voltage conditions.

While testing the $\pm$66 volt regulated power supplies, without the output stage base drive connected, use a 5 ohm 50 watt resistor to remove charge from the main filter capacitors after the unit has been switched "OFF." Information concerning power supply ripple and voltage tolerance is given in Section 3.2.7 and 3.2.8 of this instruction manual.

5.2.4 Check that the quasi-complementary symmetry output amplifier is operating properly and is not drawing excessive current under no-load conditions. Section 3.2.2 of this instruction manual describes the operation of this output amplifier.

5.2.5 Check that the overload circuitry is operating properly. The overload circuit may be disabled by removing A1CR6 and A1CR7.

5.2.6 If the problem has been resolved to be in the oscillator, consult the applicable oscillator instruction manual.

CIRCUIT DIAGRAMS

6.1 GENERAL

This section contains schematics and mechanical diagrams necessary for operation and maintenance of the Model 3001TC AC Power Source. The schematic diagrams illustrate the circuit while the mechanical assemblies indicate the part placement.

6.2 REFERENCE DESIGNATIONS

Partial reference designators are shown on schematic and mechanical drawings. Prefix these reference designators with assembly and/or subassembly designation for the complete reference designator. For example:

Assembly/Subassembly	Component	Component Designation
A1	C14	A1C14
None	T1	T1
A2	Q1	A2Q1

SCHEMATIC DIAGRAM, 3000VA POWER SOURCE

4290-091

REV	DESCRIPTION	ECN/DR	APPR
Z	ADD ITEM 114 TO P/L	4-4	LL
AA	ADD NOTE TO 4250-401-1 ASSY	4-4	JK
V	ADD ITEM 195		
W	LOCD QTY ITEM 153 FROM 16 (4 TOP, 6 BOTTOM) TO 8 (4 TOP, 4 BOTTOM) ON NOTE ITEM 183		
Y	REMOVED J5 CONN.		

TOP VIEW

FRONT PANEL
(VIEWED FROM INSIDE)

FOR PARTS LIST SEE PL 4250-400-1,-2,-5

TOP ASSEMBLY
2300 AND 3000 VA PWR SOURCE

E4250-400-M

E4250-400-AA

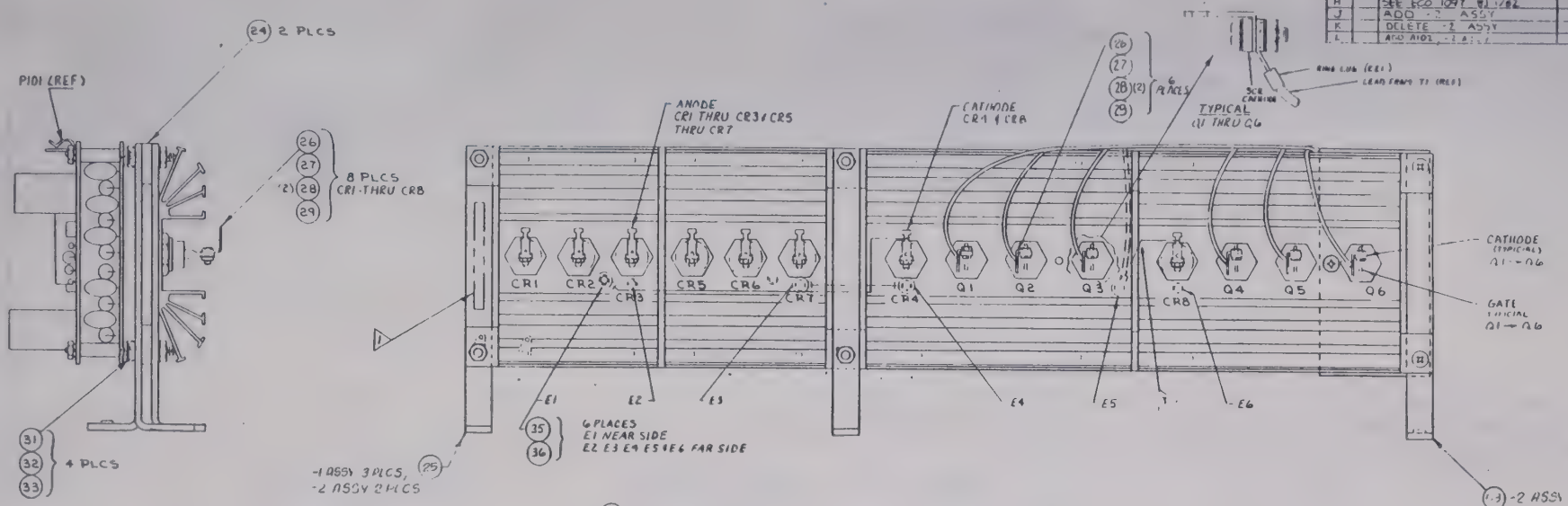
BOTTOM VIEW

REAR PANEL
(VIEWED FROM INSIDE)

DETAIL "A"
APPLY ITEM #195 TO INSIDE OF TOP COVER WITH 3M ADHESIVE AS SHOWN.

TOP ASSEMBLY :-
2500 AND 3000 VA PWR SOURCE

E4250-400MA


(24) 2 PLCS
P101 (REF)
(26) (27) (28) (2) (29) 8 PLCS CR1 THRU CR8
(31) (32) (33) 4 PLCS
ANODE CR1 THRU CR3 & CR5 THRU CR7
CATHODE CR4 & CR8
(26) (27) (28) (2) (29) 6 PLCS
TYPICAL Q1 THRU Q6
SEE CAUTION
RING LUG (REF)
LEAD FROM T1 (REF)
CR1 CR2 CR3 CR5 CR6 CR7 CR4 Q1 Q2 Q3 CR8 Q4 Q5 Q6
CATHODE (TYPICAL) Q1 → Q6
GATE TYPICAL Q1 → Q6
E1 E2 E3 E4 E5 E6
(35) (36) 6 PLACES E1 NEAR SIDE E2 E3 E4 E5 E6 FAR SIDE
(25) -1 ASSY 3 PLCS, -2 ASSY 2 PLCS
(11) -2 ASSY
(22) 2 PLCS
(23) 2 PLCS
C1 (REF)
(41) 16 PLCS
-1 PWR RECTIFIER ASSY
A102
A101
(13) (50) (52) (32) (33)
(13) (2) (32) (2) (33) (52) 2 PLCS
(51) 2 PLACES
C1
KEEP CLEAR LEAD (BOTH) AT A MINIMUM

W.T.T.

WIRE NO	FROM	TO	AWG	COLOR	MARI
1	CR4 CATH	E1	14	WHT	R4161(1) AT C1
2	E3	E4	10	WHT	R4170 (2) FAR SIDE
3	CR8 CATH	E5	14	ORN	R4161(1) ▷3
4	CR1-ANODE	Q1 CATH	14	BUS	TFL SLV
5	CR2-ANODE	Q2-CATH	14	BUS	TFL SLV
6	CR3-ANOD	Q3-CATH	14	BUS	TFL.SLV
7	CR5 ANODE	Q4-CATH	14	BUS	TFL.SLV
8	CR6-ANODE	Q5-CATH	14	BUS	TFL.SLV
9	CR7-ANOD	Q6-CATH	14	BUS	TFL SLV

A102 HARNESS WIRING TABLE (-2 ASSY ONLY)

NO	FROM	TO	AWG	TYPE	REMARKS
17	A102-E1	Q4 CATH	20	WHT	
18	A102-E2	Q5 CATH	20		
26	A102-E3	Q6-CATH	20		
27	A102-E4	Q1-CATH	20		
28	A102-E5	Q2 CATH	20		
29	A102-E6	Q3-CATH	20		
30	A102-E8	E5	20	WHT	

▷A101 & A102 ON -2 ASSY. A101 ON -1 ASSY.

▷3 SLEEVE WIRE WITH #10 TEFLON.

2. FOR SCHEMATIC DWG's SEE E 4250-070 → 2501T / E 4250-080 → 3001T / E 4250-090 → 2501TC / E 4250-091 → 3001TC.

▷1 INK STAMP ASSEMBLY NO. & REF DES "A2" APPROX AS SHOWN (NEAR SIDE).

NOTES: (UNLESS OTHERWISE SPECIFIED)

FOR PARTS LIST SEE PL 4250-401-1, -2

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APPD
A	DC	GENERAL CLEAN UP			7/3/74	
B & D	DDA	BE ROUTE WIRING, CRITICAL CLEAN UP				
G		MINOR HARDWARE CHANGE SEE DDR 0266			11/1/81	
H		SEE ECO 1097 DT 1/82				
J		ADD -2 ASSY				
K		DELETE -2 ASSY				
L		ADD A102 -1 & -2				

ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE	REQD PER ASSY

DIM IN INCHES TOLERANCES XXX = .010 XX = .03 X = .1 — BREAK ALL SHARP CORNERS & EDGES EXCEPT AS OTHERWISE PROVIDED BY CONTRACT THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

DWG SIZE D

TITLE: 3 PHASE POWER RECTIFIER ASSEMBLY (A2)

MODEL 2501T / 3001T / 3001TC / 2501TC

CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

CONTRACT NO. — CODE IDENT NO 16067

RELEASE: Jack Mueller 3/8/84

CHECKED: [illegible] 1/8/84

DESIGN: [illegible]

DRAFTSMAN: J. LARA 3/6/84

PROJ ENGR: M. Nelson 3/8/84

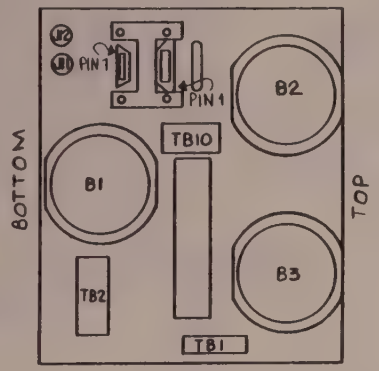
PURCHASING: [illegible] 3/8/84

DWG NO 4250-401 REV L

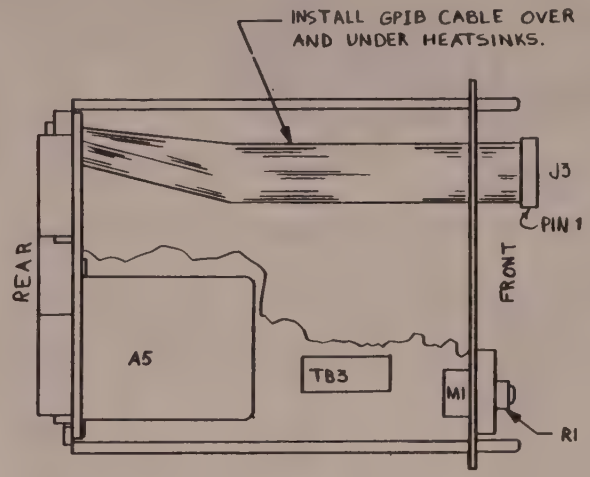
SCALE 1:1 SHEET 1 OF 1

DASH NO	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH
-1	1	E 4250-401		

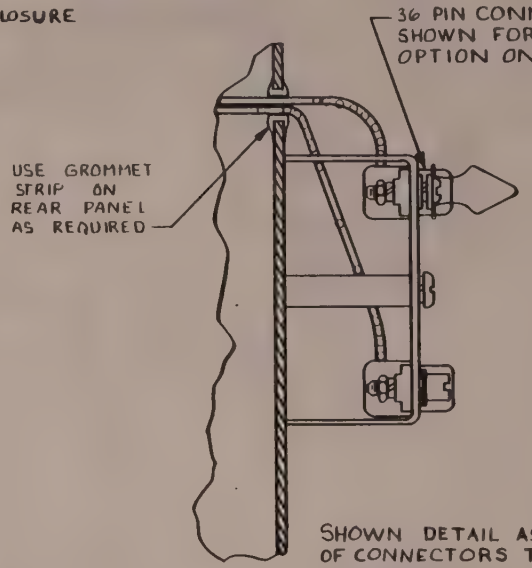
REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
	SEE SHT ONE		



REAR PANEL
VIEWED FROM OUTSIDE



TOP VIEW
(HEATSINKS REMOVED FOR CLARITY)



SHOWN DETAIL ASSEMBLY OF CONNECTORS TO REAR PANEL, USE CABLE KIT ASSEMBLY 4845-406-1, OR 4845-406-2

OPTION GPIB CABLE ASSY
SHOWN IS FOR MODEL 3001TC

4250-400 T

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO

LIST OF MATERIAL

QTY REQD	USED ON	NEXT ASSY

DIM IN INCHES TOLERANCES
XXX ± 010
XX ± 03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

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FINISH

TITLE
TOP ASSEMBLY,
2500 AND 3000 VA POWER SOURCE

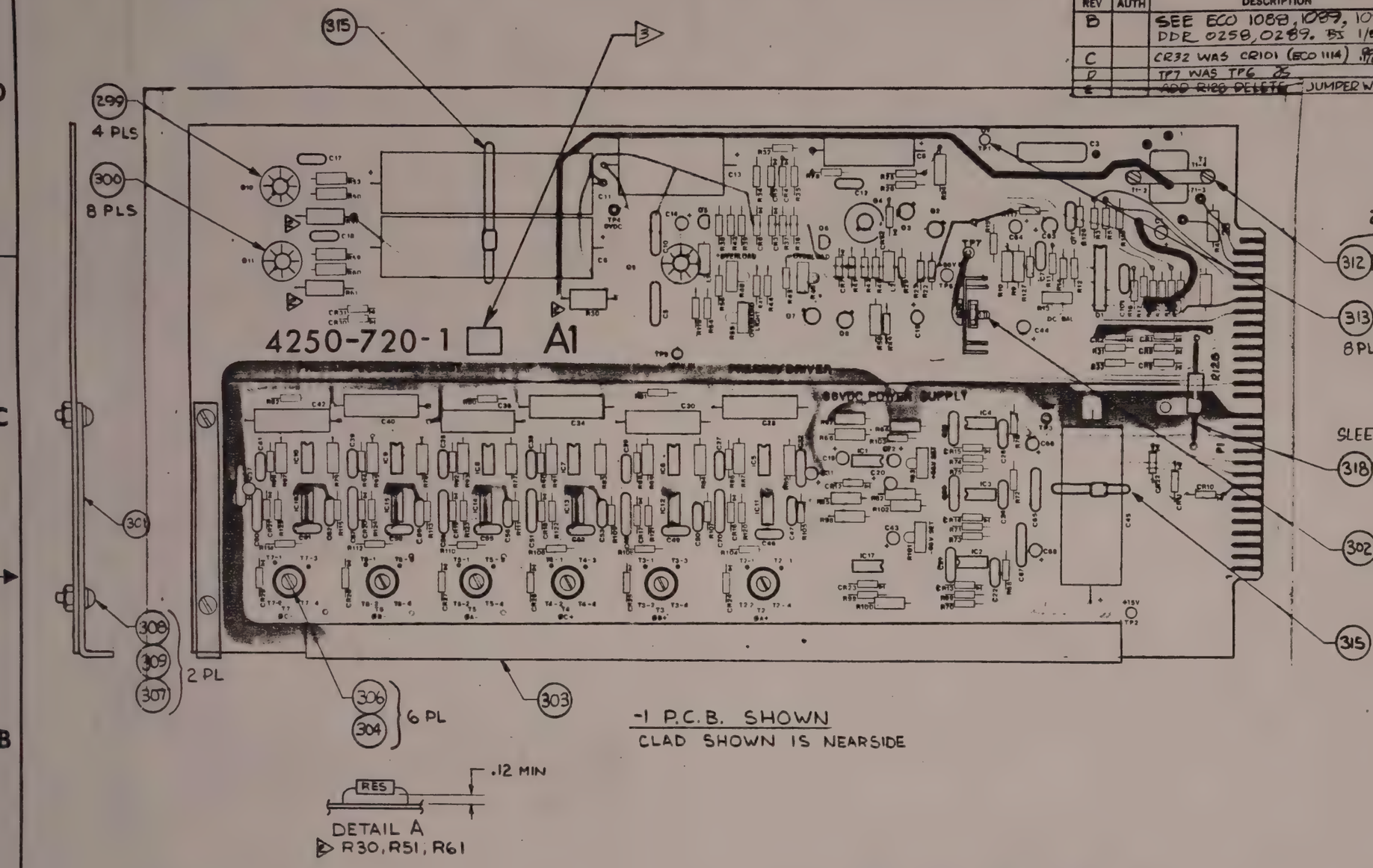
			ADDITIONAL APPROVALS
RELEASE	R. Sheppard	6/9/83	
PROJ ENG	[illegible]	6/1/83	
CHECK	Beard	6/7/83	
DESIGN	R Haase	6/9/83	
DRAFT	S. Jacketto	5/9/83	

California Instruments
A DIVISION OF AMSTAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

CONTRACT NO
CODE IDENT 16067
DWG NO 4250-400
REV T
SCALE NONE
SHEET 3 OF 3

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
B		SEE ECO 1088, 1089, 1093, DDR 0258, 0289. BS 1/02			2-1-02	
C		CR32 WAS CR101 (ECO 1114) BS 11/02			11/4/02	
D		TP7 WAS TP6 JS			8/10/05	
E		ADD R128 DELETE JUMPER WIRE			11/4/06	



FOR PARTS LIST SEE PL 4250-720-1

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

3 MARK BLOCK WITH APPROPRIATE REV LTR.

2 INSTALL R51, R61 & R30 WITH .12 MIN CLEARANCE TO P.C.B.

1. FOR SCHEMATIC DIAGRAM SEE E4250-092.

NOTES: (UNLESS OTHERWISE SPECIFIED)

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓

DWG SIZE C

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DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH
-1	1	4250-400-5 (3001TC)		
-1	1	4250-400-1 (2501TC)		

TITLE: PRINTED CIRCUIT ASSY, PRE-AMP CONTROL (A1)

MODEL 2501TC / 3001TC

RELEASE	R. Zielinski	11/4/02			
CHECKER	W. Duckett	11/4/02	PURCHASING		
DESIGN			PROJ ENGR	J. ROUSE	10-29-80
DRFTSMN	ROBB	9/80	CNF ENGR		

CALICO
CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

CONTRACT NO. | CODE IDENT 16067

DWG NO. 4250-720 | REV E

SCALE 1/1 | SHEET 1 OF 1

4250-720 E B

DRAWING 4250-720 SHEET

CALICO P-555

F9

Reg

PREAMPLIFIER/ DRIVER

OUTPUT DRIVERS & OVERLOAD SECTION

PREAMPLIFIER SECTION

66 VDC POWER SUPPLY REGULATORS

PHASE A SQUARING AMPLIFIER

PHASE B SQUARING AMPLIFIER

PHASE C SQUARING AMPLIFIER

COMMON

+66V VOLTAGE REGULATOR

-66V VOLTAGE REGULATOR

+66V ERROR INTEGRATOR

-66V ERROR INTEGRATOR

-75V REGULATOR

+25V REGULATOR

(-) REF SERVO AMP

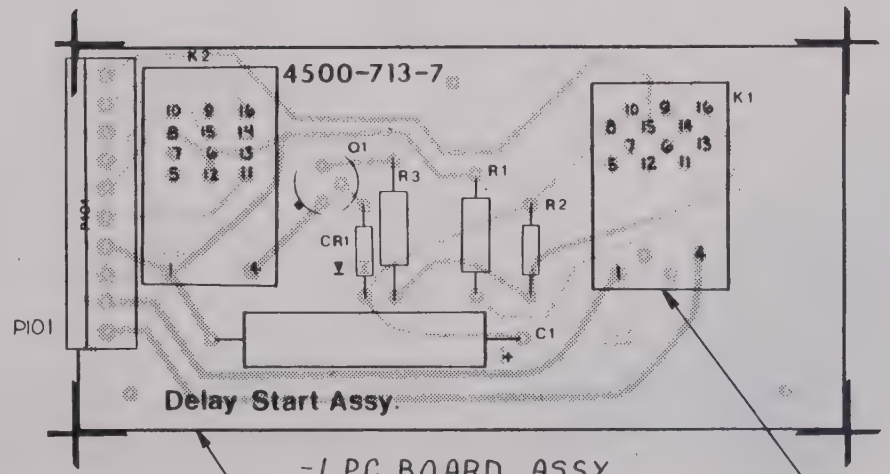
PRE-AMP & CONTROL SCHEMATIC

4250-720

WAVEFORMS SHOWN FOR OPERATION FROM 60 Hz AC LINE

3. A2, A1 POWER SUPPLY COMMON.
4. A3 POWER AMP COMMON.
3. A4 PRE AMP COMMON.
2. CAPACITANCE IN MICROFARADS
1. RESISTORS ARE ¼W, 5% IN OHMS

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD



-1 P.C. BOARD ASSY.
CLAD SHOWN IS FARSIDE

(2) (25) (26)

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
		PL. 4500-713-1	PARTS LIST	SEE SHEET 4				

DIM IN INCHES TOLERANCES
XXX = .010
XX = .03
X° = 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

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TITLE
P.C. ASSEMBLY —
DELAY START BOARD A101

MODEL 2501T - 3001T

RELEASE L. Kurtz 12-21-71

CHECKER [illegible] 12/21/71 PURCHASING

CALICO
CALIFORNIA INSTRUMENTS CORP
SAN DIEGO, CALIFORNIA

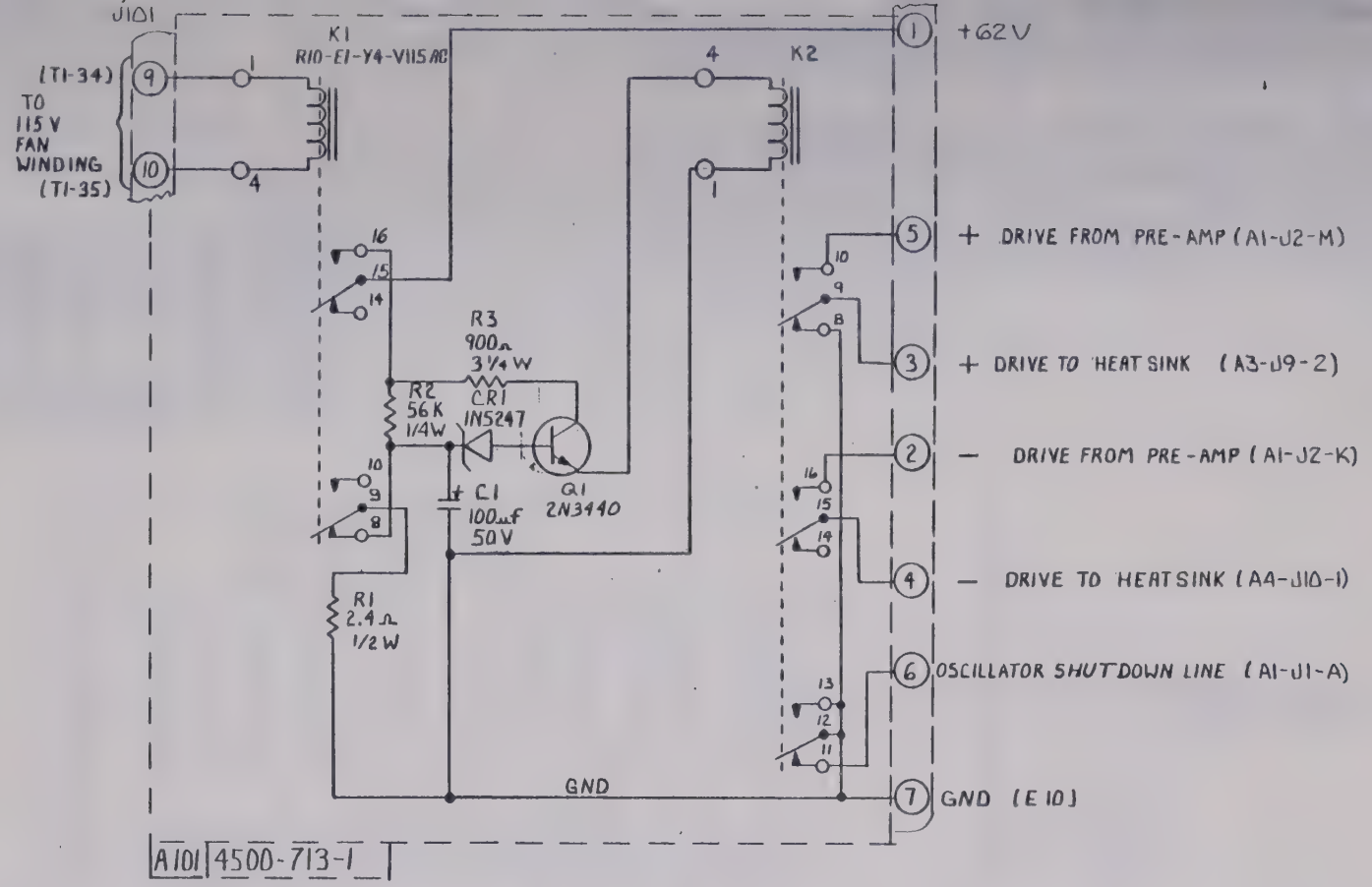
CONTRACT NO.

CODE IDENT 16067

DWG NO. 4500-713

REV C

FOR SCHEMATIC SEE C4500-085



ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
REQD PER ASSY							

DIM IN INCHES
TOLERANCES
.XXX = .010
.XX = .03
X° = 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES ✓

DWG SIZE C

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

TITLE
SCHEMATIC DIAGRAM — DELAY START CIRCUIT

MODEL 15KT 2501TC/3001TC/2501T/3001T

RELEASE	L. KURTZ	12-20-71	PURCHASING		
CHECKER		6/19/72			
DESIGN			PROJ ENGR		
DRFTSMN	AL CONSTABLE	7/10/72	CHF ENGR		

CALICO
CALIFORNIA INSTRUMENTS CORP
SAN DIEGO, CALIFORNIA

CONTRACT NO.
CODE IDENT 16067

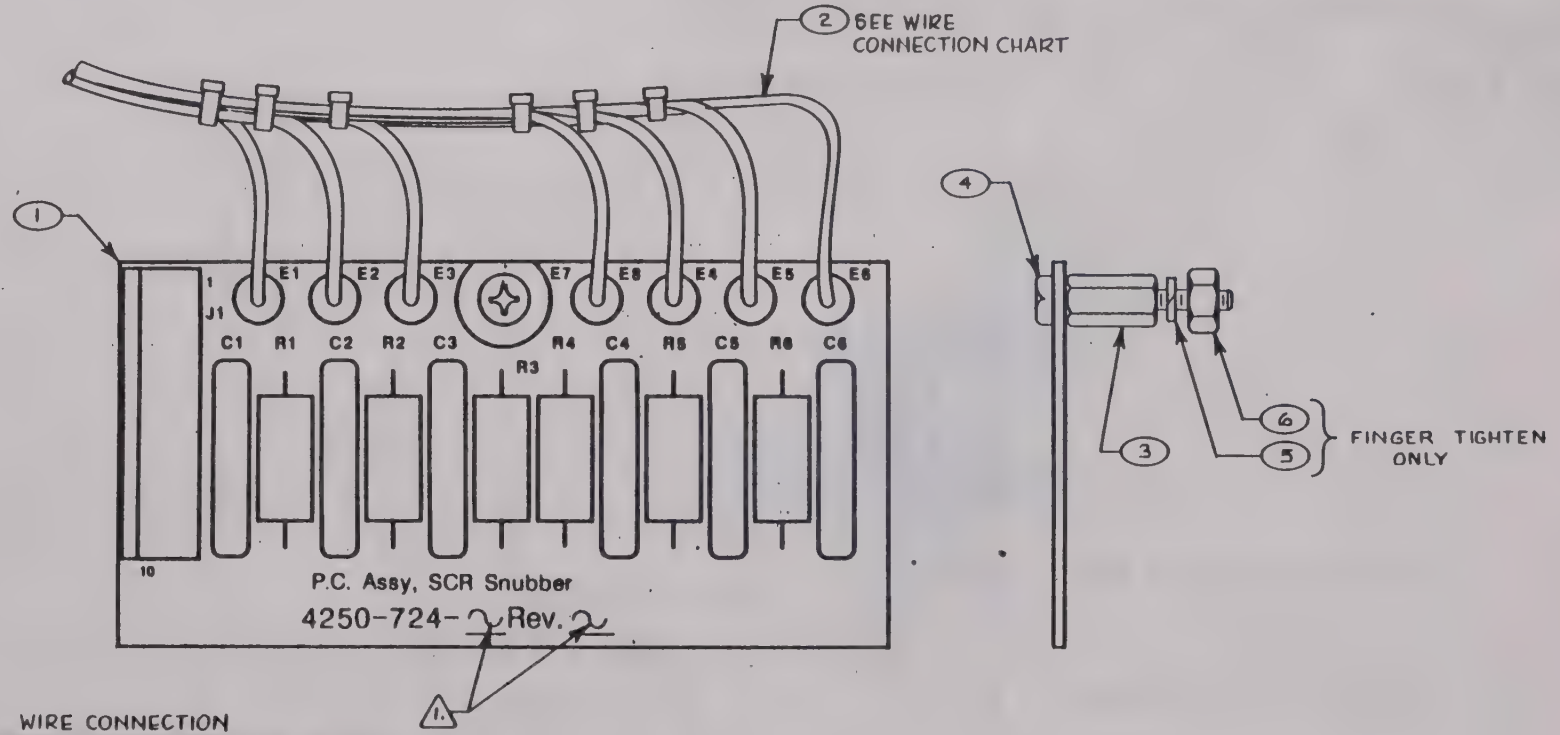
DWG NO. C4500-085
REV A

SCALE NONE
SHEET 1 OF 1

1. FOR PC BOARD ASSY AND PARTSLIST SEE 4500-713-1

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS			
REV	DESCRIPTION	DATE	APPROVED
A	ADD -3 PARTS LIST, WIRE CONNECTION CHART	4/7/86	J. Rouse



WIRE CONNECTION

-3 ASSY	WIRE	E TERM.	-1,-2 ASSY	WIRE	E TERM.
	17	E1		17	E1
	18	E2		18	E2
	26	E3		19	E3
	27	E4		22	E4
	28	E5		23	E5
	29	E6		24	E6
	30	E8		25	E8

FOR PARTS LIST SEE PL 4250-724 -1 , -2 , -3

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO.	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
1		5001TC		4250-401-1		
	1	RETROFIT		4250-436-1		
	1	3001TCA		4250-435-1		

LIST OF MATERIAL

3. MOUNT RESISTORS .25±.05 OFF BOARD.
2. FOR SCHEMATIC SEE DWG 4250-602.
1. PERMANENTLY MARK ASSY DASH NO. AND REV LTR WHERE PROVIDED.

NOTES: (UNLESS OTHERWISE SPECIFIED)

DIM IN INCHES TOLERANCES XXX ± .010 XX ± .03 X° ± 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES √
DWG SIZE C

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALIFORNIA INSTRUMENTS COMPANY AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION

FINISH

TITLE
PRINTED CIRCUIT ASSEMBLY,
SCR SNUBBER

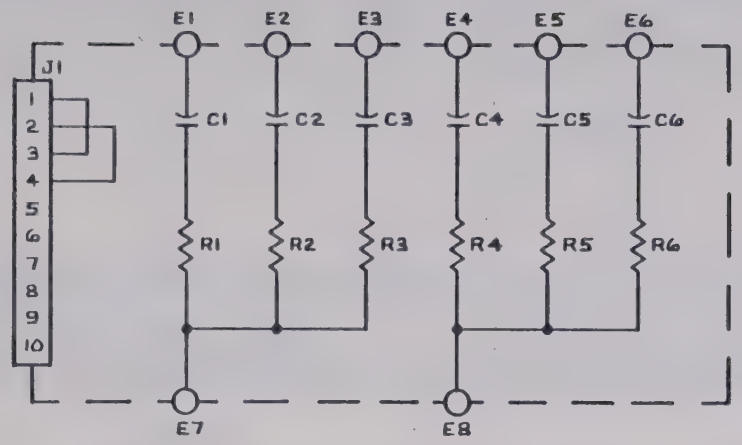
			ADDITIONAL APPROVALS
RELEASE	R Bedyard	7/25/86	
PROJ ENG	J Rouse	4-24-86	
CHECK	ERWINE	7/28/86	
DESIGN			

California INSTRUMENTS
A DIVISION OF AMSTAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

CONTRACT NO
CODE IDENT 16067

DWG NO 4250-724
REV A

4250-724



2. ALL CAPACITORS ARE .47 μF, 250 VOLT.

1. ALL RESISTORS ARE 33 Ω, 2 WATT.

NOTES: (UNLESS OTHERWISE SPECIFIED)

REQD PER ASSY	ITEM NO	PART OR IDENTIFYING NO	DESCRIPTION	MATERIAL - SPECIFICATION	CODE IDENT	NOTE NO
REF		3001TCA	4250-724			
QTY REQD		USED ON	NEXT ASSY			

LIST OF MATERIAL

DIM IN INCHES TOLERANCES
XXX ± 010
XX ± 03
X° ± 30'

BREAK ALL SHARP CORNERS & EDGES
MACH SURFACES

DWG SIZE C

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FINISH ———

TITLE
SCHEMATIC, SCR SNUBBER

			ADDITIONAL APPROVALS
RELEASE	B. Lindgren	4/25/86	
PROJ ENG	J. Rouse	4-24-86	
CHECK	ERWINE	4/22/86	
DESIGN			
DRAFT	BEACH	4-86	M'Cracken 4/86

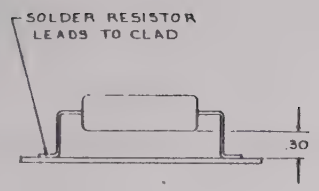
California INSTRUMENTS
A DIVISION OF AMBTAR TECHNICAL PRODUCTS CO INC
SAN DIEGO CALIFORNIA

CONTRACT NO
CODE IDENT 16067
DWG NO 4250-602
REV
SCALE NONE
SHEET 1 OF 1

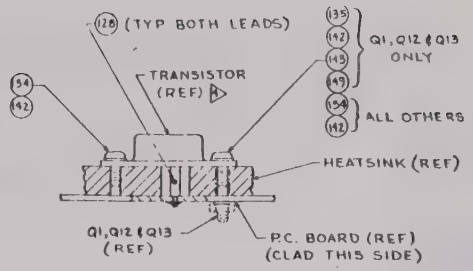
4250-602

4 3 2 1

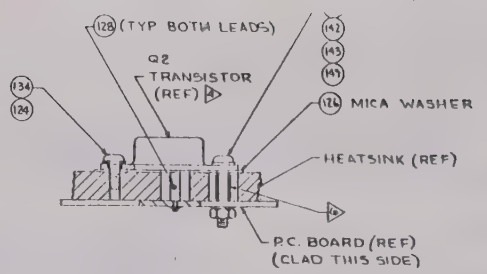
D	SEE DDR 04CB 10/MAR 82
E	ADDED C2 AND R25



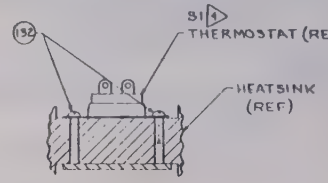
DETAIL A
TYP R1 THRU R23


(128) (TYP BOTH LEADS)
(135) (142) (145) (149) Q1, Q12 & Q13 ONLY
(154) (142) ALL OTHERS
(134) (142)
TRANSISTOR (REF)
HEATSINK (REF)
Q1, Q12 & Q13 (REF)
P.C. BOARD (REF) (CLAD THIS SIDE)

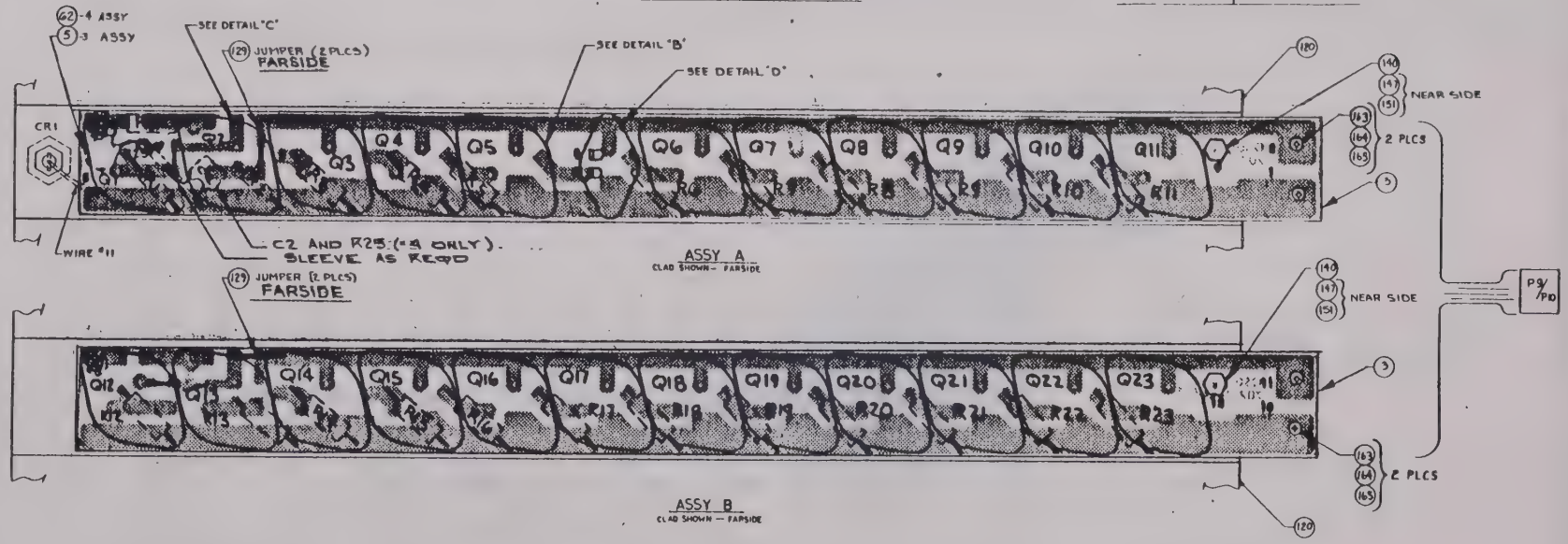
DETAIL B
TYP Q1 & Q3 THRU Q23



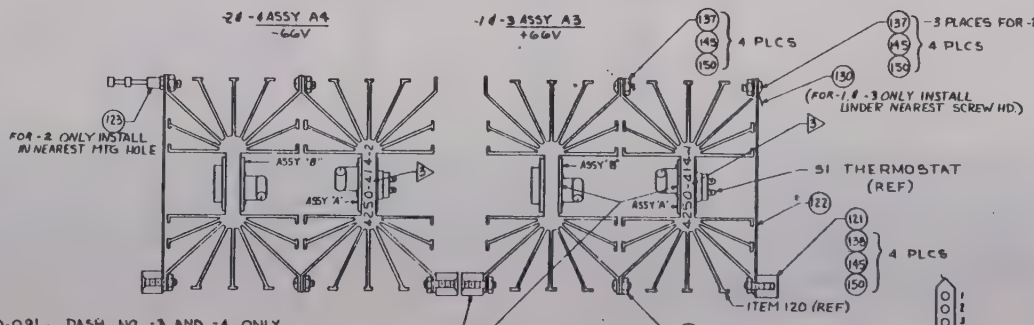
DETAIL C
Q2 FOR ASSY A ONLY



DETAIL D
S1 FOR ASSY A ONLY



ASSY		WIRE TAB TABLE				
-1 & -3	-2 & -4	WIRE NO	FROM PAD NO	TO	WIRE & COLOR	APPROX LENGTH IN INCHES
–	–	1	—	—	—	—
–	–	2	—	—	—	—
X		3	A3-5	P9-5	#22 GREEN	14"
	X	4	A4-5	P10-5	#22 GREEN	14"
X		5	A3-4	P9-4	#22 GRN	14"
	X	6	A4-4	P10-4	#22 GREEN	14"
X		7	A3-2A	P9-1	#20 RED	6"
	X	8	A4-6	P10-2	#20 BLUE	14"
X		9	A3-7	P9-2	#20 ORANGE	20"
	X	10	A4-7	P10-1	#20 GREEN	20"
X	X	11	B	CR1	18 BUSS	—
–	–	12	—	—	—	—
X	X	13	PAD 10	PAD 1	B WHT	5 (FOR BOTH A3 & A4 ASSY)
X	X	14	PAD 11	PAD 2	18 WHT	5 (FOR BOTH A3 & A4 ASSY)
–	–	15	—	—	—	—


-2 & -4 ASSY A4 -66V
-1 & -3 ASSY A3 +66V
(123) FOR -2 ONLY INSTALL IN NEAREST MTG HOLE
ASSY 'B'
ASSY 'A'
4250-414-2
4250-414-1
(137) (145) (150) 4 PLCS
(137) (145) (150) -3 PLACES FOR -2 & -4 ASSY
(130) (FOR -1 & -3 ONLY INSTALL UNDER NEAREST SCREW HD.)
(3)
S1 THERMOSTAT (REF)
(22)
(121) (138) (145) (150) 4 PLCS
ITEM 120 (REF)
P.C. BOARDS TO EXTEND OUT NEAR SIDE
(157) (145) (150) 4 PLCS
(121) (138) (145) (150) 4 PLCS

DETAIL P9, P10
PIN CONFIGURATION

FOR PARTS LIST SEE PL 4250-414-1

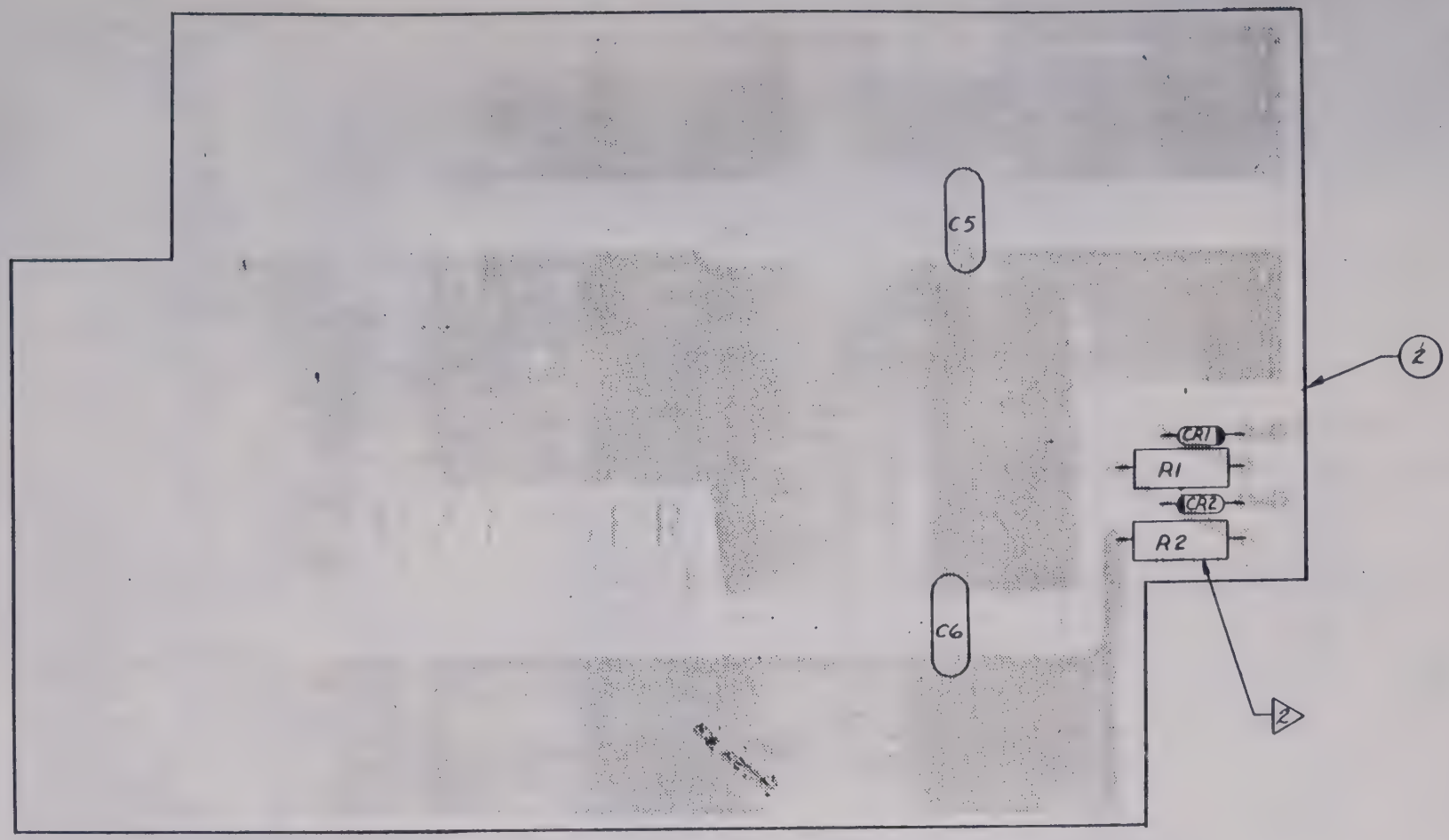
1. FOR SCHEMATIC SEE DRAWING NO. E 4250-091. DASH NO. -3 AND -4 ONLY.
2. ITEM 135 TO BE INSULATED FROM HEATSINK, USING TEFLON SLEEVING OVER SCREW THDS. (FOR Q2)
3. Q2 MUST BE INSULATED FROM HEATSINK PER DETAIL "C".
4. APPLY ITEM 125 BETWEEN TRANSISTORS AND HEATSINK AND BETWEEN S1 & HEAT SINK.
5. INK STAMP ASSY PART NO. APPROX AS SHOWN.
6. IDENTIFY WIRES WITH ITEM 127
7. FOR SCHEMATIC SEE DRAWING NO. E4250-080. DASH NO. -1 AND -2 ONLY.

-1 & -3 ASSY SHOWN (A5)
-2 & -4 ASSY SAME AS -1 EXCEPT AS NOTED AND PER WIRE TAB TABLE (A4)

ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	ORDER AS UNIT	FINISH

TITLE	OUTPUT HEATSINK ASSY -66V AND +66V
SIZE	E
DRAWING NO.	4250-414
SCALE	NONE
SHEET	1 OF 1

CALICO



FOR PARTS LIST SEE PL 4250-704-1 & -2

-1 PC BOARD ASSY

CLAD & COMPONENTS ARE NEAR SIDE

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES √

DWG SIZE C

TITLE: CAPACITOR BUSS A7 BOARD ASSEMBLY

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MODEL 2501T / 3001T / 3001TC / 2501TC

CONTRACT NO.

CODE IDENT 16067

DASH NO	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH
-2	1	4250-435		
-1	1	4250-400		

RELEASE S Taylor 9/7/84

CHECKER

DESIGN

DRFTSMN J Devine 7/7/84

PURCHASING

PROJ ENGR J Rouse 9/6/84

CHF ENGR

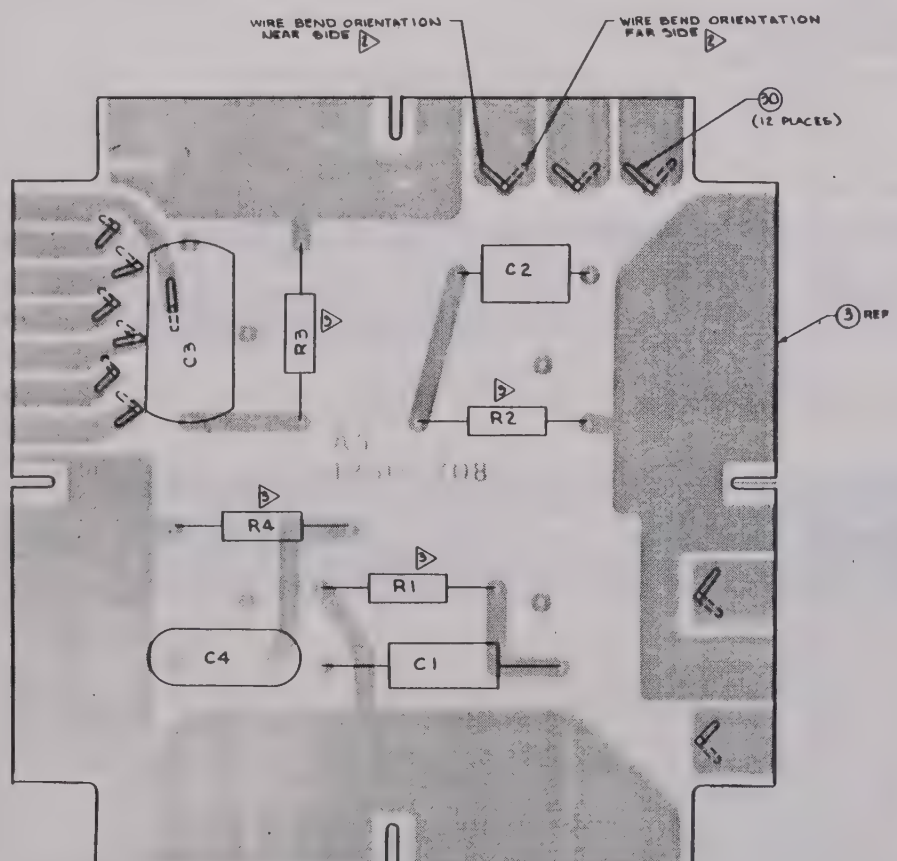
DWG NO. C4250-704 REV B

SCALE 2/1 SHEET 1

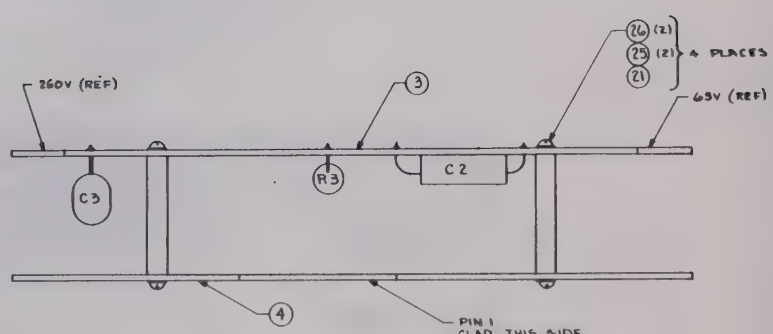
2> SPACE R1 & R2 1/8" OFF BOARD

1. FOR SCHEMATIC SEE E4250-070 - 2501T / E4250-080 - 3001T
   E4250-090 - 2501TC / E4250-091 - 3001TC

NOTES (UNLESS OTHERWISE SPECIFIED)



COMPONENT SIDE OF ITEM NO. 3
(CLAD SHOWN IS NEAR SIDE)



-1 ASSY
NO SCALE

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD

3 SPACE R1 THRU R4 1/4 OFF BOARD.

2 INSERT ITEM 30 & BEND EACH SIDE AS SHOWN SOLDER TO CLAD BOTH SIDE.

1. FOR SCHEMATIC SEE DWG D4250-079.

NOTES: (UNLESS OTHERWISE SPECIFIED)

PL 4250-415 PARTS LIST SEE SHEET 3

ITEM NO.	PART NUMBER	PART NAME	MATERIAL – SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
REQD PER ASSY							

DIM IN INCHES TOLERANCES .XXX = ±.010 .XX = ±.03 X° = ±1° | BREAK ALL SHARP CORNERS & EDGES SMOOTH SURFACES | DWG SIZE D | TITLE SELECTOR CARD ASSY A5

MODEL 3001T / 3001TC

CALICO — CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

CONTRACT NO. | CODE IDENT 16067

DWG NO. D4250-415 REV /

SCALE 2X SHEET 2 OF 3

RELEASE J. Woods 9/16/68

CHECKED 9/6/68 PURCHASING

DESIGN PROJ ENGR

DRAFTSMAN J. Sims 9-3-68 QUAL ENGR

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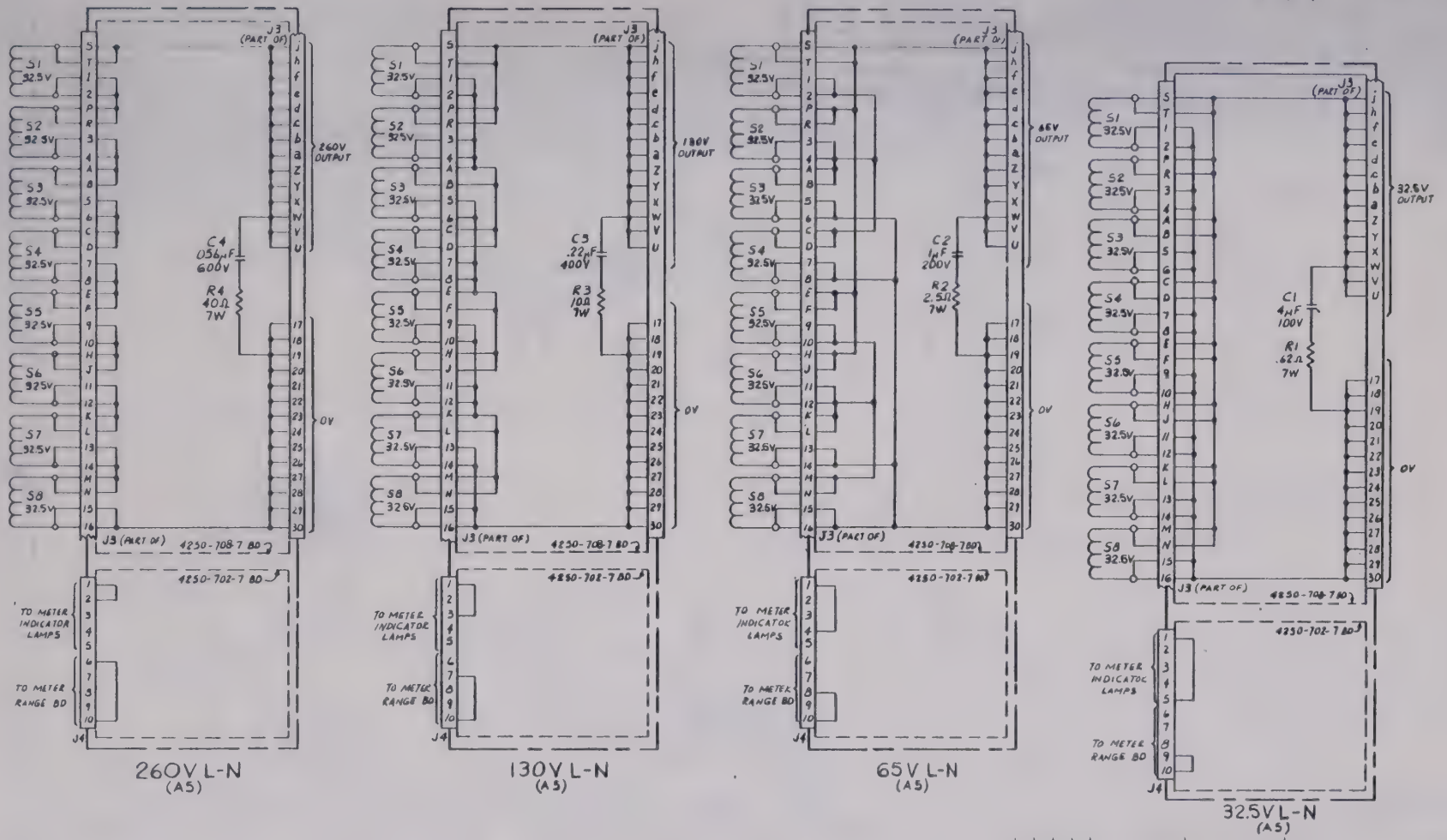

2. FOR UNIT SCHEMATIC DIAGRAM, SEE E4250-080, → 3001T AND E4250-091 → 3001TC.
1. FOR ASSEMBLY DWG, SEE D4250-415.

NOTES: (UNLESS OTHERWISE SPECIFIED)

REVISIONS

REV	AUTH	DESCRIPTION	ZONE	ECT ON	DATE	APRD

REQD PER ASSY	ITEM NO	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES	ZONE

DIM IN INCHES TOLERANCES XXX = ±.010 XX = ±.03 X° = ±.30

BREAK ALL SHARP CORNERS & EDGES TEACH SURFACES

DWG SIZE D

TITLE SCHEMATIC DIAGRAM OUTPUT SELECTOR ASSY

MODEL 3001T / 3001TC

RELEASE

CHECKED

DESIGN

DRAFTSMAN M.MARTIN 7-14-75

PROJ ENGR

CHF ENGR

PURCHASING

CALIFORNIA INSTRUMENTS CORP SAN DIEGO, CALIFORNIA

CONTRACT NO.

CODE IDENT 16067

DWG NO D4250-079 REV —

SCALE NONE SHEET OF

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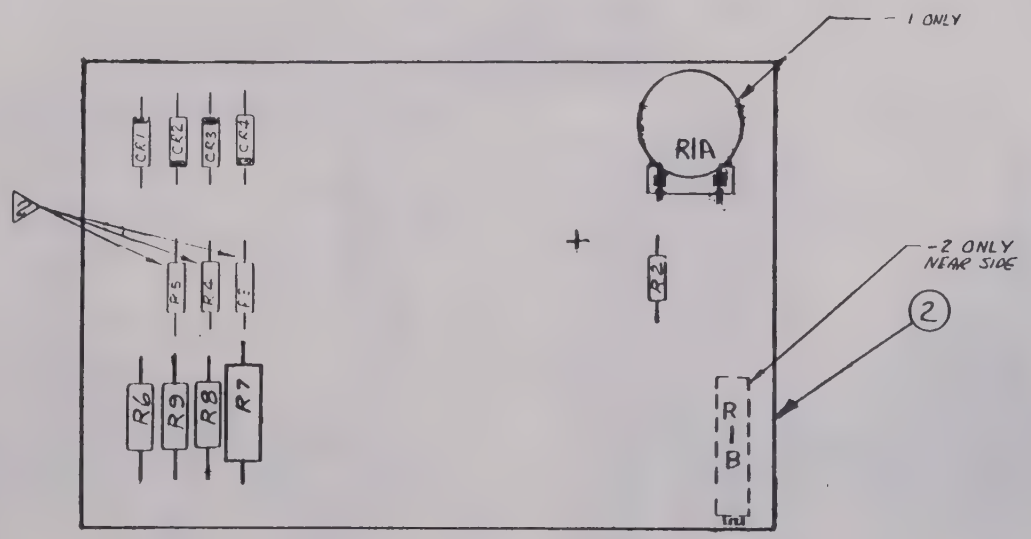
DASH NO | QTY REQD | NEXT ASSEMBLY | EFF ON | AUTH

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD



A6
-1 ASSEMBLY
VIEWED FROM COMPONENT SIDE

C4050-702 C

REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE
-1		PL 4050-702 PARTS LIST ON SHEET 4						

DIM IN INCHES TOLERANCES XXX = .010 XX = .03 X° = 30'
BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓
DWG SIZE C

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TITLE: VOLTMETER P.C. BOARD ASSY

MODEL: ALL A.C. POWER SOURCES (AC)

RELEASE	E Chris	7/1/
CHECKER	Jensen	7/15/
DESIGN		
DRFTSMN	R. Dawe	7/7/

PURCHASING, PROJ ENGR, CHF ENGR

CALIFORNIA INSTRUMENTS CORP. SAN DIEGO, CALIFORNIA

CONTRACT NO. | CODE IDENT 16067

DWG NO. C 4050-702 | REV D

SCALE 2/1 | SHEET 1 OF 1

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

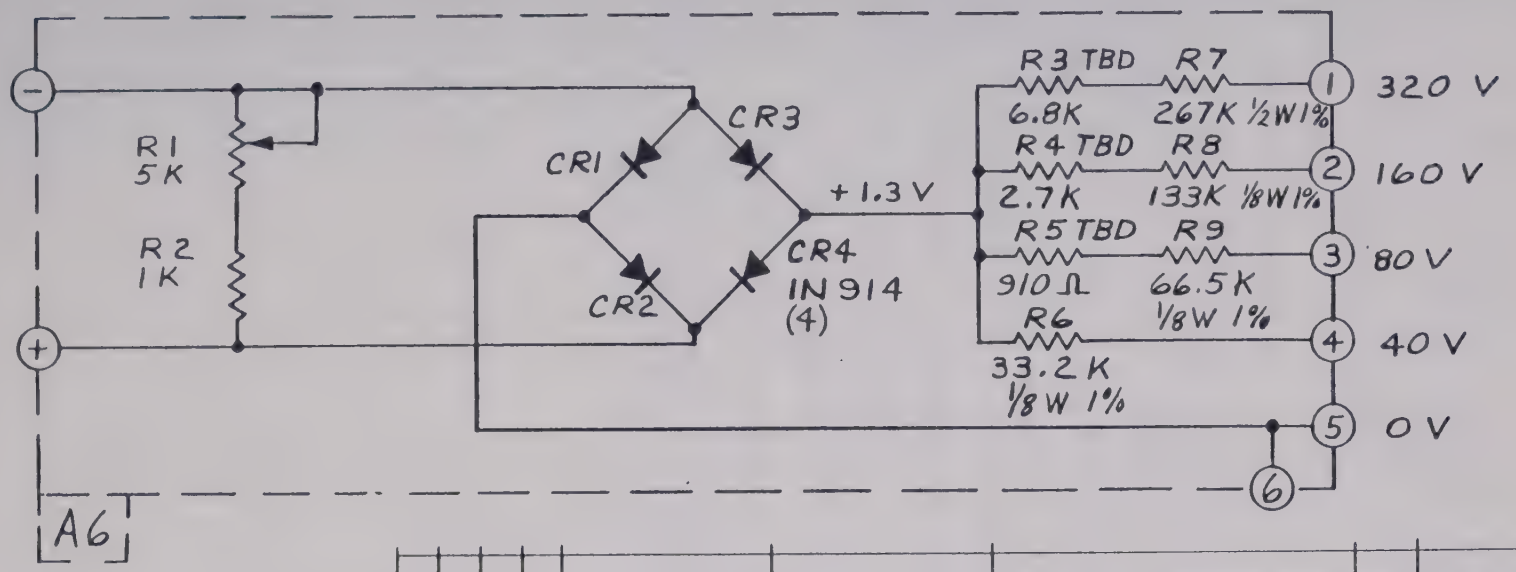
2 MOUNT R3, R4, & R5 FAR SIDE.

1. FOR SCHEMATIC SEE DWG NO. B 4050-072

NOTES: (UNLESS OTHERWISE SPECIFIED)

B4050-072 A

REVISIONS						
REV	AUTH	DESCRIPTION	ZONE	EFF ON	DATE	APRD
A		ADDED EYELET NO.6 Dawes			12/14/64	



REQD PER ASSY	ITEM NO.	PART NUMBER	PART NAME	MATERIAL — SPECIFICATION	CODE IDENT	FINISH	REF DES.	ZONE

3. PREFIX "A6" TO BE USED WITH ALL REF DES. (EXAMPLE: A6R1)
2. FOR ASSY SEE D4050-702
1. ALL RESISTORS ARE ¼W 5%

NOTES: (UNLESS OTHERWISE SPECIFIED)

DIM IN INCHES TOLERANCES .XXX = .010 .XX = .03 X° = 30'

BREAK ALL SHARP CORNERS & EDGES MACH SURFACES ✓

DWG SIZE B

EXCEPT AS OTHERWISE PROVIDED BY CONTRACT, THESE DRAWINGS AND SPECIFICATIONS ARE THE PROPERTY OF CALICO AND SHALL NOT BE REPRODUCED OR COPIED OR USED AS THE BASIS FOR THE MANUFACTURE OR SALE OF APPARATUS WITHOUT WRITTEN PERMISSION.

DASH NO.	QTY REQD	NEXT ASSEMBLY	EFF ON	AUTH

TITLE: SCHEMATIC DIAGRAM VOLTMETER P.C. BD.

MODEL: ALL "T" SERIES AC INVERTRONS

RELEASE	E. Chelitz	11/7/64	PURCHASING	
CHECKER	[illegible]	7/15/64	PROJ ENGR	
DESIGN			CHF ENGR	
DRFTSMN	D. Dawes	5/6/64		

CALIFORNIA INSTRUMENTS CORP.
SAN DIEGO, CALIFORNIA

CONTRACT NO.

CODE IDENT 16067

DWG NO. B4050-072 REV A

SCALE NONE SHEET 1 OF 1

CALICO F 101

REPLACEABLE PARTS

7.1 GENERAL

This section contains ordering information and complete list of replaceable parts. Parts are listed by major assembly in alphanumerical order of their reference designators. Description, manufacturers' part number, manufacturers' code ident number (see Appendix A for list of manufacturers), and California Instruments' stock number are indicated.

7.2 ORDERING INFORMATION

In order to provide our customers with prompt service on replacement parts, please provide the following information, when applicable, for each part ordered:

a) Model number and serial number of the instrument.

b) California Instruments part number of the sub-assembly where component is located.

c) Component reference designator.

d) Component description.

e) Component manufacturer's number and code ident.

f) California Instruments stock number.

All replacement parts orders should be placed with California Instruments, Division of Amstar Technical Products Co., Inc., San Diego, California, 92111-1266.

7.3 COMPUTER GENERATED PARTS LISTS

The following information is included as an explanation of the computer formatted parts list column.

7.3.1 "Seq. No." - Sequence number; the reference designator or the component, or (if there is no reference designator) the balloon number (bubble or "find" number) on the face of the assembly drawing or the top assembly drawing. They are listed in alphanumerical order.

7.3.2 "Component Item No." - This is California Instruments part number. Please use this number when ordering spares.

7.3.3 "Description, Truncated" - A brief description of the item. Abbreviations are per MIL-STD-12 or industry accepted standards.

7.3.4 "Engineering Drawing No." - This is used for one of the following:

a) The document/specification number generated by California Instruments to control the part.

b) The generic part number (military specification or industry accepted standard).

c) The primary vendor's catalog part number. An asterisk at the end of the number indicates number is longer than that shown (contact California Instruments if the full number is required).

7.3.5 "Vendor" - This is the FSCM code identification (see Appendix A).

7.3.6 "Quan" and "U/M" - The requirements per unit of measure such as: "2 each"; "1 lb."; "4 oz."; or "6 SI" (square inches).

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
	4250-060-0	HARNESS ASSY,JUMPER	4250-060 REV E	16067	1.0	EA
	4250-060-1	HARNESS ASSY	4250-060 REV E	16067	1.0	EA
	4250-060-2	HARNESS ASSY	4250-060 REV E	16067	1.0	EA
	4250-060-3	HARNESS ASSY	4250-060 REV E	16067	1.0	EA
	4250-060-4	HARNESS ASSY	4250-060 REV E	16067	1.0	EA
	4250-426-1	FRONT PANEL ASSY	4250-426 REV 0	16067	1.0	EA
CB1	270081	CIRCUIT BREAKER,25A,240V*	CF3-G3-U-25-*	74193	1.0	EA
DS1	241107	LAMP,GAS	NE51H(B2A)	71744	1.0	EA
DS2	241028	LAMP,INCAND	1819	03507	1.0	EA
DS3	241022	LAMP,GAS,RED,120V	BG03RCSNE2H/33K	03797	1.0	EA
DS4	241022	LAMP,GAS,RED,120V	BG03RCSNE2H/33K	03797	1.0	EA
DS5	241022	LAMP,GAS,RED,120V	BG03RCSNE2H/33K	03797	1.0	EA
DS6	241022	LAMP,GAS,RED,120V	BG03RCSNE2H/33K	03797	1.0	EA
DS7	250304	LAMP,INCAND,55V	1835	03507	1.0	EA
J6	240041	BINDING POST,RED	DF-31RC	58474	1.0	EA
J7	240090	BINDING POST,WHT	DF-31WTC	58474	1.0	EA
J8	240040	BINDING POST,BLK	DF-31BC	58474	1.0	EA
M1	CIC800	METER,DC,ANLG,MA,0-1	CIC800-0	16067	1.0	EA
M1	CIC800-2	MTR FACE,MTL,W/4050-013	CIC800/4995-285	16067	1.0	EA
R1	570128	POT,PNL,10K,1/2W,PREC	B4010-012-1	16067	1.0	EA
R9	570252	POT,MT,PC,100 OHM	89PBR-100 OHM	73138	1.0	EA
TB6	250086	TERMINAL STRP, 6TERM,1MT	901	83330	1.0	EA
DS1	241113	INDICATOR,110-125V,YEL	135-0463-1433-*	72619	1.0	EA
DS2	241112	INDICATOR,110-125V,RED	135-0410-1471-*	72619	1.0	EA
DS7	241112	INDICATOR,110-125V,RED	135-0410-1471-*	72619	1.0	EA
86	110577-2	PANEL,FRONT W/4250-108	4250-201-2	16067	1.0	EA
100	110194	SUPPORT,COVER	4100-218-1	16067	1.0	EA
103	240224	HANDLE,FLT,STEEL,6"	11520-S-0832-4	06540	4.0	EA
105	240233	KNOB,BLK	PS-70-2-BLK	21604	1.0	EA
	4250-427-1	REAR PANEL ASSY	4250-427 REV 0	16067	1.0	EA
B1	241172	FAN,6",115VAC,50/60HZ	MODEL 12	99743	1.0	EA
B2	241172	FAN,6",115VAC,50/60HZ	MODEL 12	99743	1.0	EA
B3	241172	FAN,6",115VAC,50/60HZ	MODEL 12	99743	1.0	EA
J11	240040	BINDING POST,BLK	DF-31BC	58474	1.0	EA
J12	240090	BINDING POST,WHT	DF-31WTC	58474	1.0	EA
TB1	241123	TERMINAL BLK,12TERM, 5A	410-Y-12	75382	1.0	EA
TB2	250172	TERMINAL BLK, 5TERM,85A	9-85-5	75382	1.0	EA
TB4	250050	TERMINAL STRP, 3TERM,2MT	3003	83330	1.0	EA
TB5	250111	TERMINAL STRP, 2TERM,2MT	3002	83330	1.0	EA
110	240321	TERMINAL BLK, 3TERM,85A	9-85-3	75382	1.0	EA
94	110590	BRACKET,PLUG-IN,SEL CARD	4250-213-7	16067	1.0	EA
104	241124	GUIDE,PWB,4.15"	33-9016-12-01-*	91662	4.0	EA
107	210119	GROMMET,RUBBER,3/8"DIA	2170	83330	2.0	EA
108	210611	GROMMET,RUBBER,3/4"DIA	2186	83330	1.0	EA
109	210089	GROMMET,RUBBER,7/8"DIA	2187	83330	1.0	EA
113	210074	FAN GUARD	5506	23936	3.0	EA
116	FS3016	CABLE CLAMP,7/16"ID	CLE-7/16	51705	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	U
117	FS3004	CABLE CLAMP,1/4"ID	CLE-1/4	51705	2.0	E
119	250090	JUMPER,TERMINAL BLOCK	410J	75382	1.0	E
125	210396	SCREW,RDH,S/S,4-40X1/2	4-40X1/2 ROUND	81349	4.0	E
144	110597	BRACKET,MOUNTING,PWB	1647	91833	1.0	E
148	210613	SCREW,RDH,S/S,8-32X1-1/4	8-32X1-1/4 RDH	81349	4.0	EA
206	110775-1	PANEL,REAR W/4250-202	4250-230-2	16067	1.0	EA
209	250159	STRAP,SHORTING	4115	05276	1.0	EA
	4250-428-1	ENCLOSURE ASSY	4250-428 REV 0	16067	1.0	EA
C1	611067	CAP,AL,36000UF,75V	FAHM36000-75-D6	14655	1.0	EA
C2	611067	CAP,AL,36000UF,75V	FAHM36000-75-D6	14655	1.0	EA
C3	611067	CAP,AL,36000UF,75V	FAHM36000-75-D6	14655	1.0	EA
C4	611067	CAP,AL,36000UF,75V	FAHM36000-75-D6	14655	1.0	EA
R3	550211	RES,PWR,30W,250 OHM	F315	44655	1.0	EA
R4	550211	RES,PWR,30W,250 OHM	F315	44655	1.0	EA
R5	550184	RES,PWR,50W,.02 OHM,5%	RH-50-73-.02	91637	1.0	EA
R6	550184	RES,PWR,50W,.02 OHM,5%	RH-50-73-.02	91637	1.0	EA
TB3	250302	TERMINAL BLK, 2TERM,90A	605-2	75382	1.0	EA
85	110663	ENCLOSURE	4250-229-1	16067	1.0	EA
92	110588	BRACKET,MOUNTING,H/S	4250-210-1	16067	2.0	EA
93	110589	BRACKET,MOUNTING,H/S	4250-211-1	16067	4.0	EA
95	210608	GUIDE,PWB	4250-214-7	16067	2.0	EA
98	110592	BRACKET,MOUNTING,CONN	4250-219-7	16067	1.0	EA
106	241052	CAP CLAMP,3"	4586-2	56289	4.0	EA
111	210091	NUT,SPEED,6-32	C8020-632	78553	12.0	EA
116	FS3004	CABLE CLAMP,1/4"ID	CLE-1/4	51705	1.0	EA
142	210612	SCREW,FLH,S/S,8-32X1-1/4	MS24693-56	81349	2.0	EA
143	210105	GROMMET,RUBBER,5/16"DIA	2172	83330	1.0	EA
146	210644	SCREW,RDH,S/S,10-32X3	10-32X3 ROUNDHD	81349	1.0	EA
197	110777	HEATSINK,RH50	4250-240-7	16067	1.0	EA
198	110778	HEATSINK,RH50	4250-240-8	16067	2.0	EA
A1	4250-720-1	PC ASSY,PREAMP	4250-720 REV E	16067	1.0	EA
A2	4250-401-2	HEATSINK ASSY,RECT 3 PH	4250-401 REV L	16067	1.0	EA
A3	4250-414-3	HEATSINK ASSY,OUT DRIVER	4250-414 REV E	16067	1.0	EA
A4	4250-414-4	HEATSINK ASSY,OUT DRIVER	4250-414 REV E	16067	1.0	EA
A5	4250-415-1	PC ASSY,SELECT,OUT RANGE	4250-415 REV A1	16067	1.0	EA
A6	4050-702-1	PC ASSY,METER,VOLT	4050-702 REV E1	16067	1.0	EA
A7	4250-704-1	PC ASSY,CAPACITOR BUS	4250-704 REV B	16067	1.0	EA
C8	610129	CAP,CER,.1UF,50V	CK104	71590	1.0	EA
C105	611001	CAP,MYLAR,10UF,400V	ZD4A106	12406	1.0	EA
E2	250094	LUG,RING,SOLDER,#4	1416-4	83330	1.0	EA
FL1	710321	TRANSFORMER,REACTOR,FILT	4250-025-1	16067	1.0	EA
FL2	710321	TRANSFORMER,REACTOR,FILT	4250-025-1	16067	1.0	EA
R102	550104	RES,PWR,7W,.1 OHM,5%	RS-7-.1 OHM	91637	1.0	EA
T1	710322	TRANSFORMER,INPUT	4250-026-1	16067	1.0	EA
T2	710320	TRANSFORMER,OUTPUT	4250-024-1	16067	1.0	EA
90	110586	COVER,TOP	4250-203-7	16067	1.0	EA
91	110587	COVER,BOTTOM	4250-204-7	16067	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
96	110591	COVER,SELECTOR CARD	4250-216-7	16067	1.0	EA
97	210609	WIND TUNNEL,HEATSINK	4250-217-7	16067	1.0	EA
114	250053	LUG,RING,SOLDER,#8	1416-8	83330	1.0	EA
115	210617	CABLE CLAMP,3/4"ID,AL	MS9352-11	18076	1.0	EA
116	FS3004	CABLE CLAMP,1/4"ID	CLE-1/4	51705	1.0	EA
118	FS3000	GROMMET,STRIP,.052	CSG-06-NATURAL	95987	10.0	IN
120	FS1020	SCREW,PNH,S/S,4-40X5/8	MS51957-18	96906	14.0	EA
121	FS1018	SCREW,PNH,S/S,4-40X1/2	MS51957-17	96906	5.0	EA
123	FS1026	SCREW,PNH,S/S,6-32X1/4	MS51957-26	96906	8.0	EA
124	FS1028	SCREW,PNH,S/S,6-32X5/16	MS51957-27	81349	29.0	EA
126	FS1031	SCREW,PNH,S/S,6-32X7/16	MS51957-29	81349	12.0	EA
129	FS1041	SCREW,PNH,S/S,8-32X5/16	MS59157-42	81349	8.0	EA
130	FS1051	SCREW,PNH,S/S,8-32X5/8	MS51957-46	96906	14.0	EA
131	FS1052	SCREW,PNH,S/S,8-32X3/4	MS51957-47	96906	6.0	EA
132	FS1052	SCREW,PNH,S/S,8-32X3/4	MS51957-47	96906	8.0	EA
133	FS1056	SCREW,PNH,S/S,10-32X3/8	MS51958-61	81349	9.0	EA
135	210271	BOLT,HEX,S/S,1/4-20X1/2	MS35307-303	96906	20.0	EA
138	FS1029	SCREW,FLH,S/S,6-32X3/8	MS24693-C26	96906	10.0	EA
141	FS1046	SCREW,FLH,S/S,8-32X5/8	MS24693-C51	96906	4.0	EA
145	FS1061	SCREW,FLH,S/S,10-32X1/2	MS24693-C272	96906	7.0	EA
151	FS1080	WASHER,FLAT,S/S,#6	MS15795-806	96906	1.0	EA
152	FS1081	WASHER,FLAT,S/S,#8	MS15795-841	96906	6.0	EA
153	210097	WASHER,FLAT,1/4	MS15795-810	96906	5.0	EA
156	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	18.0	EA
157	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	56.0	EA
158	FS1070	WASHER,INTER,S/S,#8	MS35333-72	81349	70.0	EA
159	FS1071	WASHER,INTER,S/S,#10	MS35333-73	96906	14.0	EA
165	210459	WASHER,SPLT,1/4	MS35338-139	96906	20.0	EA
168	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	8.0	EA
169	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	15.0	EA
170	FS1065	NUT,HEX,S/S,8-32	MS35649-284	96906	51.0	EA
171	FS1067	NUT,HEX,S/S,10-32	MS35650-304	96906	8.0	EA
172	210298	NUT,HEX,S/S,1/4-20	MS35649-2254	96906	1.0	EA
176	FS4002	ADHESIVE/SEALANT,SIL,BLK	RTV-103	01139	.2	OZ
177	FS3008	MOUNTING CRADLE,WIRE TIE	WTMC-1	51705	2.0	EA
178	FS3009	WIRE TIE,31/2	WRN-31/2	51705	2.0	EA
199	FS1001	SCREW,FLH,S/S,6-32X5/16	MS24693-C25	81349	8.0	EA

SINGLE-LEVEL B.O.M.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	FS2003	LUG,RING,CRIMP,8-10	R3031BF	14726	21.0	EA
2	FS2006	LUG,RING,CRIMP,16/14-6	R61005GSF	14726	18.0	EA
3	FS2004	LUG,RING,CRIMP,12/10-6	R4183F	14726	6.0	EA
4	FS2014	LUG,SPADE,CRIMP,16/14-4	BS41270S	14726	4.0	EA
5	FS2010	LUG,RING,CRIMP,6-10	R4001BF	14726	2.0	EA

SINGLE-LEVEL B.O.M.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
J1	410260	CONN,PC EDGE,10 PIN	8BDJ10S-0	81312	1.0	EA
J2	410178	CONN,PC EDGE,28 PIN	8BD28S-0	81312	1.0	EA
J4	410032	CONN,PC EDGE,10 PIN	8BD10S-0	81312	1.0	EA
J9	410220	CONN,RCPT,5 PIN	03-06-1055	27264	1.0	EA
J10	410220	CONN,RCPT,5 PIN	03-06-1055	27264	1.0	EA
101	410295	CONN,PC HSG,10 PIN	09-50-3101	27264	1.0	EA
1	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	1.0	EA
2	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	6.0	EA
3	410293	TERMINAL,CRIMP	08-56-0105	27264	10.0	EA
4	410221	TERMINAL,CRIMP	02-06-5103	27264	8.0	EA
5	FS2005	LUG,RING,CRIMP,16/14-10	R4161F	14726	2.0	EA

SINGLE-LEVEL B.O.M.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	FS2003	LUG,RING,CRIMP,8-10	R3031BF	14726	5.0	EA
2	FS2004	LUG,RING,CRIMP,12/10-6	R4183F	14726	3.0	EA
3	FS2006	LUG,RING,CRIMP,16/14-6	R61005GSF	14726	1.0	EA
4	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	6.0	EA
6	FS2005	LUG,RING,CRIMP,16/14-10	R4161F	14726	1.0	EA

SINGLE-LEVEL B.O.M.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	2.0	EA
2	FS2024	LUG,RING,CRIMP,12/10-1/4	R4171F	14726	2.0	EA
3	FS2010	LUG,RING,CRIMP,6-10	R4001BF	14726	2.0	EA
4	FS2009	LUG,RING,CRIMP,6-1/4	R4002BF	14726	2.0	EA
5	FS2003	LUG,RING,CRIMP,8-10	R3031BF	14726	1.0	EA

SINGLE-LEVEL B.O.M.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
1	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	1.0	EA

SINGLE-LEVEL B.O.M.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
CR1	310251	DIODE,ZNR,8.2V,.5W,5%	1N5237B	04713	1.0	EA
CR2	310196	DIODE,ZNR,6.8V,.5W,5%	1N5235B	04713	1.0	EA
CR3	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR4	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR5	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR6	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR7	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR8	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR9	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR10	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR11	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR12	310206	DIODE,ZNR,12V.5W,5%	1N5242B	04713	1.0	EA
CR13	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR14	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR15	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR16	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR17	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR18	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR19	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR20	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR21	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR22	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR23	310206	DIODE,ZNR,12V.5W,5%	1N5242B	04713	1.0	EA
CR24	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR25	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR26	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR27	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR28	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR29	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR30	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR31	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR32	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
C1	610761	CAP,TANT,1UF,20V	T362A105M020AS	05397	1.0	EA
C3	610942	CAP,PC,2UF,50V	C5A205J	12406	1.0	EA
C5	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0	EA
C6	610743	CAP,AL,250UF,100V	39D257F100GPA	56289	1.0	EA
C7	610531	CAP,MYLAR,.022UF,100V	1DP-1-223K	72136	1.0	EA
C8	610235	CAP,MYLAR,.47UF,200V	ZA2C474	27556	1.0	EA
C10	610127	CAP,CER,.1UF,100V	TG-P10	56289	1.0	EA
C11	610743	CAP,AL,250UF,100V	39D257F100GPA	56289	1.0	EA
C12	610042	CAP,MICA,330PF,500V	CM05F331J03	81349	1.0	EA
C13	611021	CAP,AL,50UF,200V	TVA-1443	56289	1.0	EA
C14	610798	CAP,TANT,2.2UF,25V	T362B225M025AS	05397	1.0	EA
C15	610798	CAP,TANT,2.2UF,25V	T362B225M025AS	05397	1.0	EA
C17	610027	CAP,MICA,100PF,500V	CM05F101J03	81349	1.0	EA
C18	610027	CAP,MICA,100PF,500V	CM05F101J03	81349	1.0	EA
C19	610863	CAP,TANT,100UF,20V	T362D107M020AS	05397	1.0	EA

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C20	610802	CAP,TANT,4.7UF,25V	T362B475M025AS	05397	1.0	EA
C21	610460	CAP,CER,.05UF,50V	CK503	71590	1.0	EA
C22	610770	CAP,CER,5000PF,100V	TG-D50	56289	1.0	EA
C23	610460	CAP,CER,.05UF,50V	CK503	71590	1.0	EA
C24	610770	CAP,CER,5000PF,100V	TG-D50	56289	1.0	EA
C25	610460	CAP,CER,.05UF,50V	CK503	71590	1.0	EA
C26	610770	CAP,CER,5000PF,100V	TG-D50	56289	1.0	EA
C27	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C28	611022	CAP,MYLAR,.47UF,100V,2%	Z1A47G	12406	1.0	EA
C29	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C30	611022	CAP,MYLAR,.47UF,100V,2%	Z1A47G	12406	1.0	EA
C31	610967	CAP,TANT,22UF,15V	T362A226M015AS	05397	1.0	EA
C32	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C33	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C34	611022	CAP,MYLAR,.47UF,100V,2%	Z1A47G	12406	1.0	EA
C35	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C36	611022	CAP,MYLAR,.47UF,100V,2%	Z1A47G	12406	1.0	EA
C37	610967	CAP,TANT,22UF,15V	T362A226M015AS	05397	1.0	EA
C38	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C39	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C40	611022	CAP,MYLAR,.47UF,100V,2%	Z1A47G	12406	1.0	EA
C41	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C42	611022	CAP,MYLAR,.47UF,100V,2%	Z1A47G	12406	1.0	EA
C43	610802	CAP,TANT,4.7UF,25V	T362B475M025AS	05397	1.0	EA
C44	610803	CAP,TANT,4.7UF,50V	T362B475M050AS	05397	1.0	EA
C45	610529	CAP,AL,1000UF,50V	WBR1000-50	14655	1.0	EA
C46	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C47	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C48	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C49	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C50	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C51	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C52	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C53	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C54	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C55	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C56	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C57	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C58	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C59	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C60	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C61	610094	CAP,CER,.01UF,50V	CK103	71590	1.0	EA
C62	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C63	610816	CAP,TANT,100UF,6V	T362C107M006AS	05397	1.0	EA
C64	610816	CAP,TANT,100UF,6V	T362C107M006AS	05397	1.0	EA
C65	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C66	610967	CAP,TANT,22UF,15V	T362A226M015AS	05397	1.0	EA

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C67	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C68	610967	CAP,TANT,22UF,15V	T362A226M015AS	05397	1.0	EA
C70	611007	CAP,CER,.1UF,25V	TCA-104Z	02799	1.0	EA
C71	FS7002	CAP,TBD	TBD	81349	1.0	EA
C72	610802	CAP,TANT,4.7UF,25V	T362B475M025AS	05397	1.0	EA
C101	610476	CAP,CER,500PF,500V	CE501	71590	1.0	EA
IC1	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0	EA
IC2	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0	EA
IC3	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0	EA
IC4	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0	EA
IC5	360026	IC,TIMER	NE555V	18324	1.0	EA
IC6	360026	IC,TIMER	NE555V	18324	1.0	EA
IC7	360026	IC,TIMER	NE555V	18324	1.0	EA
IC8	360026	IC,TIMER	NE555V	18324	1.0	EA
IC9	360026	IC,TIMER	NE555V	18324	1.0	EA
IC10	360026	IC,TIMER	NE555V	18324	1.0	EA
IC11	360026	IC,TIMER	NE555V	18324	1.0	EA
IC12	360026	IC,TIMER	NE555V	18324	1.0	EA
IC13	360026	IC,TIMER	NE555V	18324	1.0	EA
IC14	360026	IC,TIMER	NE555V	18324	1.0	EA
IC15	360026	IC,TIMER	NE555V	18324	1.0	EA
IC16	360026	IC,TIMER	NE555V	18324	1.0	EA
IC17	360030	IC,OP-AMP,GP,COMPENSATED	LM741CN	27014	1.0	EA
IC18	360251	IC,VOLTAGE REG,+15,1A	MC7815CT	04713	1.0	EA
L1	590005	INDUCTOR,RF,200UH	1537-90	99800	1.0	EA
L2	590005	INDUCTOR,RF,200UH	1537-90	99800	1.0	EA
Q1	330252	TRANSISTOR,ARRAY,N/P,DIP	CA3096AE	95303	1.0	EA
Q2	330141	TRANSISTOR,SS,PNP,TO5	2N5415	95303	1.0	EA
Q3	330141	TRANSISTOR,SS,PNP,TO5	2N5415	95303	1.0	EA
Q4	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	EA
Q5	330219	TRANSISTOR,SS,NPN,TO92	2N5172	81349	1.0	EA
Q6	330204	TRANSISTOR,SS,PNP,TO92	2N5087	04713	1.0	EA
Q7	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	EA
Q8	330141	TRANSISTOR,SS,PNP,TO5	2N5415	95303	1.0	EA
Q9	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	EA
Q10	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	EA
Q11	330141	TRANSISTOR,SS,PNP,TO5	2N5415	95303	1.0	EA
R1	560661	RES,FILM,1/4W,82.5K,1%	RN60C8252F	81349	1.0	EA
R3	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R4	560166	RES,FILM,1/4W,750K,1%	RN60D7503F	81349	1.0	EA
R5	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R9	560067	RES,FILM,1/4W,7.5K,1%	RN60D7501F	81349	1.0	EA
R10	560067	RES,FILM,1/4W,7.5K,1%	RN60D7501F	81349	1.0	EA
R11	510050	RES,CARB,1/4W,750 OHM	RC07GF751J	81349	1.0	EA
R12	560221	RES,FILM,1/4W,200 OHM,1%	RN60C2000F	81349	1.0	EA
R13	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R14	560221	RES,FILM,1/4W,200 OHM,1%	RN60C2000F	81349	1.0	EA

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R15	560503	RES,FILM,1/4W,7.5K,1%	RN60C7501F	81349	1.0	EA
R16	560551	RES,FILM,1/4W,3.48K,1%	RN60C3481F	81349	1.0	EA
R17	510060	RES,CARB,1/4W,2.2K OHM	RC07GF222J	81349	1.0	EA
R18	560503	RES,FILM,1/4W,7.5K,1%	RN60C7501F	81349	1.0	EA
R19	560503	RES,FILM,1/4W,7.5K,1%	RN60C7501F	81349	1.0	EA
R20	560062	RES,FILM,1/4W,6.19K,1%	RN60C6191F	81349	1.0	EA
R21	560062	RES,FILM,1/4W,6.19K,1%	RN60C6191F	81349	1.0	EA
R22	560487	RES,FILM,1/4W,511 OHM,1%	RN60C5110F	81349	1.0	EA
R23	560487	RES,FILM,1/4W,511 OHM,1%	RN60C5110F	81349	1.0	EA
R24	560715	RES,FILM,1/4W,2.74K,1%	RN60C2741F	81349	1.0	EA
R25	560475	RES,FILM,1/4W,124 OHM,1%	RN60C1240F	81349	1.0	EA
R26	560475	RES,FILM,1/4W,124 OHM,1%	RN60C1240F	81349	1.0	EA
R28	510090	RES,CARB,1/4W,39K OHM	RC07GF393J	81349	1.0	EA
R29	510025	RES,CARB,1/4W,68 OHM	RC07GF680J	81349	1.0	EA
R30	550215	RES,PWR,3-1/4W,900 OHM	4421	44655	1.0	EA
R31	510014	RES,CARB,1/4W,24 OHM	RC07GF240J	81349	1.0	EA
R32	510066	RES,CARB,1/4W,3.9K OHM	RC07GF392J	81349	1.0	EA
R33	510014	RES,CARB,1/4W,24 OHM	RC07GF240J	81349	1.0	EA
R34	510074	RES,CARB,1/4W,8.2K OHM	RC07GF822J	81349	1.0	EA
R35	FS5118	WIRE,BUS,AWG 24,QQ-W-343E	QQW343S24S2B	81348	1.0	IN
R36	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R37	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R38	510088	RES,CARB,1/4W,33K OHM	RC07GF333J	81349	1.0	EA
R39	510005	RES,CARB,1/4W,10 OHM	RC07GF100J	81349	1.0	EA
R40	510005	RES,CARB,1/4W,10 OHM	RC07GF100J	81349	1.0	EA
R41	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R42	510088	RES,CARB,1/4W,33K OHM	RC07GF333J	81349	1.0	EA
R43	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R44	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R45	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R46	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R47	510055	RES,CARB,1/4W,1.2K OHM	RC07GF122J	81349	1.0	EA
R48	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R49	510025	RES,CARB,1/4W,68 OHM	RC07GF680J	81349	1.0	EA
R50	520048	RES,CARB,1/2W,3.9K OHM	RC20GF392J	81349	1.0	EA
R51	550034	RES,PWR,3-1/4W,350 OHM,5%	4405	44655	1.0	EA
R53	520044	RES,CARB,1/2W,2.7K OHM	RC20GF272J	81349	1.0	EA
R54	510029	RES,CARB,1/4W,100 OHM	RC07GF101J	81349	1.0	EA
R55	570153	POT,1T,PC,100 OHM,1/4W	X201R101B	71450	1.0	EA
R56	510011	RES,CARB,1/4W,18 OHM	RC07GF180J	81349	1.0	EA
R58	520036	RES,CARB,1/2W,1.2K OHM	RC20GF122J	81349	1.0	EA
R59	520044	RES,CARB,1/2W,2.7K OHM	RC20GF272J	81349	1.0	EA
R60	520048	RES,CARB,1/2W,3.9K OHM	RC20GF392J	81349	1.0	EA
R61	550034	RES,PWR,3-1/4W,350 OHM,5%	4405	44655	1.0	EA
R62	560715	RES,FILM,1/4W,2.74K,1%	RN60C2741F	81349	1.0	EA
R63	570155	POT,1T,PC,500 OHM,1/4W	X201R501B	71450	1.0	EA
R64	560436	RES,FILM,1/4W,61.9K,1%	RN60C6192F	81349	1.0	EA

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R65	560702	RES,FILM,1/4W,2.67K,1%	RN60C2671F	81349	1.0	EA
R66	560238	RES,FILM,1/4W,4.99K,1%	RN60C4991F	81349	1.0	EA
R67	560036	RES,FILM,1/4W,2.61K,1%	RN60C2611F	81349	1.0	EA
R68	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R69	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R70	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R71	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R72	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R73	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R74	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R75	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R76	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R77	560688	RES,FILM,1/4W,1.69K,1%	RN60C1691F	81349	1.0	EA
R78	560688	RES,FILM,1/4W,1.69K,1%	RN60C1691F	81349	1.0	EA
R79	560688	RES,FILM,1/4W,1.69K,1%	RN60C1691F	81349	1.0	EA
R80	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R81	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R82	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R83	560688	RES,FILM,1/4W,1.69K,1%	RN60C1691F	81349	1.0	EA
R84	560688	RES,FILM,1/4W,1.69K,1%	RN60C1691F	81349	1.0	EA
R85	560688	RES,FILM,1/4W,1.69K,1%	RN60C1691F	81349	1.0	EA
R86	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R87	560638	RES,FILM,1/4W,16.5K,1%	RN60C1652F	81349	1.0	EA
R88	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R89	560638	RES,FILM,1/4W,16.5K,1%	RN60C1652F	81349	1.0	EA
R90	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R91	560638	RES,FILM,1/4W,16.5K,1%	RN60C1652F	81349	1.0	EA
R92	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R93	560638	RES,FILM,1/4W,16.5K,1%	RN60C1652F	81349	1.0	EA
R94	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R95	560638	RES,FILM,1/4W,16.5K,1%	RN60C1652F	81349	1.0	EA
R96	510092	RES,CARB,1/4W,47K OHM	RC07GF473J	81349	1.0	EA
R97	560638	RES,FILM,1/4W,16.5K,1%	RN60C1652F	81349	1.0	EA
R98	510069	RES,CARB,1/4W,5.1K OHM	RC07GF512J	81349	1.0	EA
R99	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R100	560243	RES,FILM,1/4W,7.32K,1%	RN60C7321F	81349	1.0	EA
R101	570177	POT,1T,PC,2.5K,1/4W	X201R252B	71450	1.0	EA
R102	560436	RES,FILM,1/4W,61.9K,1%	RN60C6192F	81349	1.0	EA
R103	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R104	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	EA
R105	510090	RES,CARB,1/4W,39K OHM	RC07GF393J	81349	1.0	EA
R106	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	EA
R107	510090	RES,CARB,1/4W,39K OHM	RC07GF393J	81349	1.0	EA
R108	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	EA
R109	510090	RES,CARB,1/4W,39K OHM	RC07GF393J	81349	1.0	EA
R110	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	EA
R111	510090	RES,CARB,1/4W,39K OHM	RC07GF393J	81349	1.0	EA

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R112	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	EA
R113	510090	RES,CARB,1/4W,39K OHM	RC07GF393J	81349	1.0	EA
R114	510021	RES,CARB,1/4W,47 OHM	RC07GF470J	81349	1.0	EA
R115	510090	RES,CARB,1/4W,39K OHM	RC07GF393J	81349	1.0	EA
R116	510076	RES,CARB,1/4W,10K OHM	RC07GF103J	81349	1.0	EA
R117	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R119	510088	RES,CARB,1/4W,33K OHM	RC07GF333J	81349	1.0	EA
R120	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R121	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R122	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R123	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R124	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R125	510083	RES,CARB,1/4W,20K OHM	RC07GF203J	81349	1.0	EA
R126	FS7000	RES,CARB,1/4W,TBD	RC07GF...	81349	1.0	EA
R127	510009	RES,CARB,1/4W,15 OHM	RC07GF150J	81349	1.0	EA
R128	530001	RES,CARB,1W,10 OHM	RC32GF100J	81349	1.0	EA
T1	710130	TRANSFORMER	T31X	81095	1.0	EA
T2	710291	TRANSFORMER,TRIGGER,SCR	4250-014-1	16067	1.0	EA
T3	710291	TRANSFORMER,TRIGGER,SCR	4250-014-1	16067	1.0	EA
T4	710291	TRANSFORMER,TRIGGER,SCR	4250-014-1	16067	1.0	EA
T5	710291	TRANSFORMER,TRIGGER,SCR	4250-014-1	16067	1.0	EA
T6	710291	TRANSFORMER,TRIGGER,SCR	4250-014-1	16067	1.0	EA
T7	710291	TRANSFORMER,TRIGGER,SCR	4250-014-1	16067	1.0	EA
2	160332	PWB,PRE-AMPLIFIER	4250-770-1	16067	1.0	EA
299	240120	HEATSINK	TXBF-032-025B	98978	4.0	EA
300	240296	SOCKET,XSTR,TO-5	RCTO5075-7A	19080	8.0	EA
301	110596	BRACKET,ANGLE	3237	06540	1.0	EA
302	210497	HEATSINK,IC	PA2-1CB	98978	1.0	EA
303	FS3011	BINDING BAR,WHT,1/8"X11"	B118	33716	1.0	EA
304	210141	SCREW,RDH,NYL,4-40X5/8	N4-40X5/8	95987	6.0	EA
306	210136	NUT,HEX,NYL,4-40	N4-40-X	95987	6.0	EA
307	FS1028	SCREW,PNH,S/S,6-32X5/16	MS51957-27	81349	2.0	EA
308	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	2.0	EA
309	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	2.0	EA
310	FS1011	SCREW,PNH,S/S,4-40X1/4	MS51957-13	96906	2.0	EA
311	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	3.0	EA
312	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	3.0	EA
313	250256	TERMINAL,TURRET,SOLID	2520B-1	88245	8.0	EA
315	FS3010	WIRE TIE,51/2	WRN-51/2	51705	2.0	EA
316	FS1013	SCREW,PNH,S/S,4-40X3/8	MS51957-15	96906	1.0	EA
318	FS6011	TUBING,TEFLON,AWG 18	TFT-200-18-NAT.	92194	1.0	IN

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
A101	4500-713-1	PC ASSY,DELAY START	4500-713 REV C2	16067	1.0	EA
A102	4250-724-3	PC ASSY,SCR SNUBBER	4250-724 REV A	16067	1.0	EA
CR1	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
CR2	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
CR3	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
CR4	310257	DIODE,RECT,40A,400V,DO5	1N1188RA	07716	1.0	EA
CR5	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
CR6	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
CR7	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
CR8	310257	DIODE,RECT,40A,400V,DO5	1N1188RA	07716	1.0	EA
C1	610821	CAP,CER,.1UF,500V	5HK-P10	56289	1.0	EA
Q1	330287	THYR,SCR,63A,300V,TO65*	C147C	03508	1.0	EA
Q2	330287	THYR,SCR,63A,300V,TO65*	C147C	03508	1.0	EA
Q3	330287	THYR,SCR,63A,300V,TO65*	C147C	03508	1.0	EA
Q4	330287	THYR,SCR,63A,300V,TO65*	C147C	03508	1.0	EA
Q5	330287	THYR,SCR,63A,300V,TO65*	C147C	03508	1.0	EA
Q6	330287	THYR,SCR,63A,300V,TO65*	C147C	03508	1.0	EA
13	210830	SCREW,PNH,S/S,6-32X1-3/4	MS51957-37	81349	3.0	EA
20	FS2005	LUG,RING,CRIMP,16/14-10	R4161F	14726	2.0	EA
21	FS2012	LUG,RING,CRIMP,12/10-10	R4170F	14726	2.0	EA
22	210600	HEATSINK	4250-206-7	16067	2.0	EA
23	210601	HEATSINK	4250-207-7	16067	2.0	EA
24	210602	INSULATOR,MOUNT,HEATSINK	4250-208-7	16067	2.0	EA
25	110578	BRACKET,MOUNTING,H/S	4250-209-7	16067	2.0	EA
26	250295	LUG,ANGLE,SOLDER,#4	147	52745	14.0	EA
27	FS1006	SCREW,PNH,S/S,4-40X5/16	MS51957-14	96906	14.0	EA
28	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	28.0	EA
29	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	14.0	EA
31	FS1034	SCREW,PNH,S/S,6-32X5/8	MS51957-31	96906	4.0	EA
32	FS1073	WASHER,SPLT,S/S,#6	MS35338-136	96906	9.0	EA
33	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	9.0	EA
35	FS1054	SCREW,PNH,S/S,10-32X5/16	MS51958-60	81349	6.0	EA
36	FS1071	WASHER,INTER,S/S,#10	MS35333-73	96906	6.0	EA
41	210728	FSTNR,RVT,POP,1/8X.357	AD44ABS	07707	16.0	EA
50	210063	STANDOFF,6-32 X 1/2"	2322	83330	1.0	EA
51	250047	LUG,RING,SOLDER,#6	1416-6	83330	2.0	EA
52	210258	SPACER, #6 X 3/4"	2103	83330	3.0	EA
53	4250-209-8	BRACKET,MOUNTING H/S	4250-209-8	16067	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
CR1	310205	DIODE,ZNR,17V,.5W,10%	1N5247A	04713	1.0	EA
C1	610782	CAP,AL,100UF,50V	TE1309	56289	1.0	EA
J101	410294	CONN,PC HDR,10 PIN	09-72-1101	27264	1.0	EA
K1	245164	RELAY,CRADLE4C,5A,115VAC	R10-EI-X4-V115A	24796	1.0	EA
K2	245157	RELAY,CRADLE,4C,2A,24V	ITT25AO4C18E	15238	1.0	EA
Q1	330090	TRANSISTOR,SS,NPN,TO39	2N3440	81349	1.0	EA
R1	520132	RES,CARB,1/2W,2.4 OHM	RC20GF2R4J	81349	1.0	EA
R2	510094	RES,CARB,1/4W,56K OHM	RC07GF563J	81349	1.0	EA
R3	550215	RES,PWR,3-1/4W,900 OHM	4421	44655	1.0	EA
XK1	245154	SOCKET,RELAY,4 POLE	27E194	24796	1.0	EA
2	160316	PWB,DELAY START	4500-713-7	16067	1.0	EA
26	245152	RETAINER,RELAY,4 POLE	20C250	77132	1.0	EA

SINGLE-LEVEL B.O.M.

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
C1	611145	CAP,MYLAR,.47UF,250V	712A1ME474PK25*	80031	1.0	EA
C2	611145	CAP,MYLAR,.47UF,250V	712A1ME474PK25*	80031	1.0	EA
C3	611145	CAP,MYLAR,.47UF,250V	712A1ME474PK25*	80031	1.0	EA
C4	611145	CAP,MYLAR,.47UF,250V	712A1ME474PK25*	80031	1.0	EA
C5	611145	CAP,MYLAR,.47UF,250V	712A1ME474PK25*	80031	1.0	EA
C6	611145	CAP,MYLAR,.47UF,250V	712A1ME474PK25*	80031	1.0	EA
R1	540069	RES,CARB,2W,33 OHM	RC42GF330J	81349	1.0	EA
R2	540069	RES,CARB,2W,33 OHM	RC42GF330J	81349	1.0	EA
R3	540069	RES,CARB,2W,33 OHM	RC42GF330J	81349	1.0	EA
R4	540069	RES,CARB,2W,33 OHM	RC42GF330J	81349	1.0	EA
R5	540069	RES,CARB,2W,33 OHM	RC42GF330J	81349	1.0	EA
R6	540069	RES,CARB,2W,33 OHM	RC42GF330J	81349	1.0	EA
1	4250-774-1	PWB,SCR SNUBBER	4250-774-1	16067	1.0	EA
2	4250-060-5	HARNESS ASSY	4250-060 REV E	16067	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
CR1	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
C1	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
P9	410224	CONN,PLUG,5 PIN	03-06-2055	27264	1.0	EA
Q1	330020	TRANSISTOR,PWR,NPN,TO3	DTS410	16758	1.0	EA
Q2	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q3	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q4	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q5	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q6	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q7	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q8	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q9	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q10	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q11	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q12	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q13	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q14	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q15	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q16	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q17	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q18	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q19	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q20	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q21	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q22	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q23	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
R1	520021	RES,CARB,1/2W,150 OHM	RC20GF151J	81349	1.0	EA
R2	520006	RES,CARB,1/2W,10.0 OHM	RC20GF100J	81349	1.0	EA
R3	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R4	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R5	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R6	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R7	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R8	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R9	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R10	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R11	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R12	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R13	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R14	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R15	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R16	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R17	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R18	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R19	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R20	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R21	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
R22	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R23	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R24	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
S1	270066	THERMO-SWITCH	3450-87-149	14604	1.0	EA
3	160296	PWB,HEATSINK,OUT DRIVER	4250-707-7	16067	2.0	EA
120	210645	HEATSINK	4250-227-7	16067	2.0	EA
121	110579	INSULATOR,MOUNT,HEATSINK	4250-212-7	16067	2.0	EA
122	210610	WIND TUNNEL,HEATSINK	4250-220-7	16067	1.0	EA
124	210076	INSULATOR,SHLDR,NYL,#4	NY04-040	08289	1.0	EA
125	FS4001	THERMAL COMPOUND	351	13103	.2	OZ
126	330192	INSULATOR,MICA,TO3	DM123	08289	1.0	EA
128	FS6013	TUBING,TEFLON,AWG 14	TFT-200-14-NAT.	92194	2.0	IN
129	FS5122	WIRE,BUS,AWG 16,QQ-W-343E	QQW343S16S2B	81348	2.0	IN
130	250223	LUG,RING,SOLDER,#6	1412-6	83330	1.0	EA
132	210283	SCREW,PNH,S/S,2-56X1/4	MS51957-3	81349	2.0	EA
134	FS1006	SCREW,PNH,S/S,4-40X5/16	MS51957-14	96906	43.0	EA
135	FS1021	SCREW,PNH,S/S,4-40X3/4	MS51957-19	81349	4.0	EA
137	FS1028	SCREW,PNH,S/S,6-32X5/16	MS51957-27	81349	10.0	EA
138	FS1035	SCREW,FLH,S/S,6-32X3/4	MS24693-C30	96906	8.0	EA
140	FS1052	SCREW,PNH,S/S,8-32X3/4	MS51957-47	96906	2.0	EA
142	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	46.0	EA
143	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	96906	2.0	EA
145	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	18.0	EA
147	FS1070	WASHER,INTER,S/S,#8	MS35333-72	81349	2.0	EA
149	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	4.0	EA
150	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	18.0	EA
151	FS1065	NUT,HEX,S/S,8-32	MS35649-284	96906	2.0	EA
154	FS2003	LUG,RING,CRIMP,8-10	R3031BF	14726	2.0	EA
155	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	2.0	EA
162	410225	TERMINAL,CRIMP	02-06-6103	27264	5.0	EA
163	FS1056	SCREW,PNH,S/S,10-32X3/8	MS51958-61	81349	4.0	EA
164	FS1067	NUT,HEX,S/S,10-32	MS35650-304	96906	4.0	EA
165	FS1075	WASHER,SPLT,S/S,#10	MS35338-138	96906	4.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
CR1	310221	DIODE,RECT,40A,400V,DO5	1N1188A	07716	1.0	EA
C1	610730	CAP,CER,1000PF,1000V	DD102	71590	1.0	EA
C2	611094	CAP,MYLAR,.0047UF,400V	712A1BB472PK40*	80031	1.0	EA
P10	410224	CONN,PLUG,5 PIN	03-06-2055	27264	1.0	EA
Q1	330020	TRANSISTOR,PWR,NPN,TO3	DTS410	16758	1.0	EA
Q2	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q3	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q4	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q5	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q6	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q7	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q8	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q9	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q10	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q11	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q12	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q13	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q14	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q15	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q16	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q17	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q18	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q19	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q20	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q21	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q22	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
Q23	330281	TRANSISTOR,PWR,NPN,TO3	67334 (2N6259)	81349	1.0	EA
R1	520021	RES,CARB,1/2W,150 OHM	RC20GF151J	81349	1.0	EA
R2	520006	RES,CARB,1/2W,10.0 OHM	RC20GF100J	81349	1.0	EA
R3	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R4	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R5	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R6	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R7	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R8	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R9	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R10	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R11	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R12	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R13	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R14	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R15	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R16	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R17	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R18	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R19	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R20	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
R21	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R22	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R23	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R24	550188	RES,PWR,3W,.1 OHM,5%	RW69VR10WL	81349	1.0	EA
R25	510025	RES,CARB,1/4W,68 OHM	RC07GF680J	81349	1.0	EA
S1	270066	THERMO-SWITCH	3450-87-149	14604	1.0	EA
3	160296	PWB,HEATSINK,OUT DRIVER	4250-707-7	16067	2.0	EA
120	210645	HEATSINK	4250-227-7	16067	2.0	EA
121	110579	INSULATOR,MOUNT,HEATSINK	4250-212-7	16067	2.0	EA
122	210610	WIND TUNNEL,HEATSINK	4250-220-7	16067	1.0	EA
124	210076	INSULATOR,SHLDR,NYL,#4	NY04-040	08289	1.0	EA
125	FS4001	THERMAL COMPOUND	351	13103	.2	OZ
126	330192	INSULATOR,MICA,TO3	DM123	08289	1.0	EA
128	FS6013	TUBING,TEFLON,AWG 14	TFT-200-14-NAT.	92194	2.0	IN
129	FS5122	WIRE,BUS,AWG 16,QQ-W-343E	QQW343S16S2B	81348	2.0	IN
132	210283	SCREW,PNH,S/S,2-56X1/4	MS51957-3	81349	2.0	EA
134	FS1006	SCREW,PNH,S/S,4-40X5/16	MS51957-14	96906	43.0	EA
135	FS1021	SCREW,PNH,S/S,4-40X3/4	MS51957-19	81349	4.0	EA
137	FS1028	SCREW,PNH,S/S,6-32X5/16	MS51957-27	81349	9.0	EA
138	FS1035	SCREW,FLH,S/S,6-32X3/4	MS24693-C30	96906	8.0	EA
140	FS1052	SCREW,PNH,S/S,8-32X3/4	MS51957-47	96906	2.0	EA
142	FS1068	WASHER,INTER,S/S,#4	MS35333-70	81349	46.0	EA
143	FS1072	WASHER,SPLT,S/S,#4	MS35338-135	96906	2.0	EA
145	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	18.0	EA
147	FS1070	WASHER,INTER,S/S,#8	MS35333-72	81349	2.0	EA
149	FS1066	NUT,HEX,S/S,4-40	MS35649-244	96906	4.0	EA
150	FS1064	NUT,HEX,S/S,6-32	MS35649-264	96906	18.0	EA
151	FS1065	NUT,HEX,S/S,8-32	MS35649-284	96906	2.0	EA
154	FS2003	LUG,RING,CRIMP,8-10	R3031BF	14726	2.0	EA
155	FS2001	LUG,RING,CRIMP,22/18-10	R4149SF	14726	2.0	EA
162	410225	TERMINAL,CRIMP	02-06-6103	27264	5.0	EA
163	FS1056	SCREW,PNH,S/S,10-32X3/8	MS51958-61	81349	4.0	EA
164	FS1067	NUT,HEX,S/S,10-32	MS35650-304	96906	4.0	EA
165	FS1075	WASHER,SPLT,S/S,#10	MS35338-138	96906	4.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
C1	611016	CAP,MYLAR,4UF,100V	ZD1A405	12406	1.0	EA
C2	610591	CAP,MYLAR,1UF,200V	ZD2A105K	12406	1.0	EA
C3	611015	CAP,MYLAR,.22UF,400V	4DP-5-224	72136	1.0	EA
C4	611017	CAP,MYLAR,.056UF,600V	6DP-3-563	72136	1.0	EA
R1	550209	RES,PWR,7W,.62 OHM,5%	RS-7-.62 OHM	91637	1.0	EA
R2	550207	RES,PWR,7W,2.5 OHM,5%	RS-7-2.5 OHM	91637	1.0	EA
R3	550208	RES,PWR,7W,10 OHM,5%	RS-7-10 OHM	91637	1.0	EA
R4	550210	RES,PWR,7W,40 OHM,5%	RS-7-40 OHM	91637	1.0	EA
3	160297	PWB,SELECTOR,OUT RANGE	4250-708-7	16067	1.0	EA
4	160248	PWB,SELECTOR,OUT RANGE	4250-702-7	16067	1.0	EA
21	210599	STANDOFF,6-32 X 15/16"	8788	83330	4.0	EA
25	FS1030	SCREW,PNH,S/S,6-32X3/8	MS51957-28	96906	8.0	EA
26	FS1069	WASHER,INTER,S/S,#6	MS35333-71	96906	8.0	EA
30	FS5124	WIRE,BUS,AWG 12,QQ-W-343E	QQW343S12S2B	81348	2.0	IN

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
CR1	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR2	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR3	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
CR4	310118	DIODE,SWNG,75V,.5W,DO35	1N914	07263	1.0	EA
R1	575036	POT,1T,PC,5K,1/4W	U201R502B	71450	1.0	EA
R2	510053	RES,CARB,1/4W,1K OHM	RC07GF102J	81349	1.0	EA
R3	510072	RES,CARB,1/4W,6.8K OHM	RC07GF682J	81349	1.0	EA
R4	510062	RES,CARB,1/4W,2.7K OHM	RC07GF272J	81349	1.0	EA
R5	510052	RES,CARB,1/4W,910 OHM	RC07GF911J	81349	1.0	EA
R6	560249	RES,FILM,1/4W,33.2K,1%	RN60C3322F	81349	1.0	EA
R7	560330	RES,FILM,3/4W,267K,1%	RN70C2673F	81349	1.0	EA
R8	560329	RES,FILM,1/4W,133K,1%	RN60C1333F	81349	1.0	EA
R9	560399	RES,FILM,1/4W,66.5K,1%	RN60C6652F	81349	1.0	EA
2	157003	PWB,METER,VOLT	4050-702-7	16067	1.0	EA

SEQ NO.	COMPONENT ITEM NO.	DESCRIPTION TRUNCATED	ENGINEERING DRAWING NO.	VENDOR	QTY	UM
CR1	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
CR2	310062	DIODE,RECT,1A,400V,DO41	1N4004	81349	1.0	EA
C5	610821	CAP,CER,.1UF,500V	5HK-P10	56289	1.0	EA
C6	610821	CAP,CER,.1UF,500V	5HK-P10	56289	1.0	EA
R1	550212	RES,PWR,3-1/4W,450 OHM	4409A	44655	1.0	EA
R2	550213	RES,PWR,3-1/4W,820 OHM	4420	44655	1.0	EA
2	160259	PWB,CAPACITOR BUS	4250-704-7	16067	1.0	EA

Appendix A

Number	Vendor Name	City	State
0000A	Electricord	Westfield	PA
0000C	Jackson Bros.	Weedon,Surrey	GB
0000E(28544)	OPCDA (Defex Elect. Corp.)	Winsted	CT
0000W	Milton Roos Co.	Southampton	PA
0000Z(52765)	Timco	Los Angeles	CA
0000AC	Itac	Santa Clara	CA
0000AD(55112)	Pleasey (Westlake Cap. Inc.)	Westlake Village	CA
0000AG	Lafrance	Philadelphia	PA
0000AH(54363)	Jan Crystal	Ft. Myers	CA
0000AL(52495)	Data Components, Inc.	Gardena	CA
0000AM	Erand & Reimer	Santa Monica	CA
0000AN	Hitt Instrument Transformer	Redondo Beach	CA
0000AS	Switches Incorporated	Mt. View	CA
0000AT(62643)	United Chemi-Con	Rosemont	IL
0000AU	JAJ Technical Prod. Inc.	Kendall Park	NJ
0000AV(61837)	Semi Processes, Inc.	San Jose	CA
0000AW	Hirmec	Chatsworth	CA
0000AX(63878)	Apermeics	Nantor	OH
0000AY	Silicon Power Cube Corp.	Long Beach	CA
0000BC	Panasonic	Secaucus	NY
0000BH	Century Components	Canyon Country	CA
0000BI(54186)	Micro Power Systems	Santa Clara	CA
0000BJ(86776)	Robinson Nugent	New Albany	IN
0000BL(13158)	Beco Products (Vernitron)	Lacenia	NH
0000BN(91725)	Cerco-Comar (Gerrard AJ & Co.)	Des Plaines	IL
0000BO	Mitsubishi Electronics Amer.	Sunnyvale	CA
0000BP	Silicon Power Cube	Long Beach	CA
0000BR	Secme	Bagnolet	France
0000BS	Panel Components Corp.	Santa Rosa	CA
00544	Metzi-Cal Div., Avery Prod.	Inglewood	CA
00779	AMP Inc.	Harrisburg	PA
00853	Sangamo Electronic Co.	Pickens	SC
00866	Goe Eng. Co., Inc.	City of Industry	CA
01002	G.E. Co., Ind. & Pwr. Cap. Dept.	John St. Hudson	NY
01121	Allen-Bradley Co.	Milwaukee	WI
01139	G.E. Co., Silicone Prod.	Waterford	NY
01295	Texas Instruments	Dallas	TX
01961	Pulse Engineering, Inc.	San Diego	CA
02111	Spectrol Electronics	City of Industry	CA
02113	Ceilcraft, Inc.	Cary	IL
02335	Fairchild Controls Corp.	Hicksville,LI	NY
02375	American Insulating Mach. Co.	Philadelphia	PA
02538	Texas Electronics Co.	Dallas	TX
02640	Amphenol Corporation	Broadview	IL
02748	Illinois Tool Works, Inc.	Des Plains	IL
02799	See Code 972136		
03507	General Electric Company	Syracuse	NY
03508	General Electric Company	Syracuse	NY
03797	Eldema Corporation	Compton	CA
03888	Pyrofilm Resistor Co., Inc.	Cedar Knolls	NJ
03911	Claires Corporation	New York	NY
04009	Arrow-Hart and Hegeman Elec.	Hartford	CT
04099	Capax, Inc.	Grand Junction	CO
04713	Motorola Semiconductor Prod.	Phoenix	AZ
04779	Universal Components Corp.	Green Brook	NJ
04963	3-M	St. Paul	MN
05245	Corcom Inc.	Chicago	IL
05276	Pomona Electronics., Inc.	Pomona	CA
05397	Kemet, Union Carbide Corp.	Cleveland	OH
05791	Lyn-Tron, Inc.	Burbank	CA
05820	Wakefield Engineering, Inc.	Wakefield	MA
05972	Loctite Corp.	Newington	CT
06383	Panduit Corp.	Tinley Park	IL
06514	Standtron, Spece Metal Prod.,	N. Hollywood	CA
06540	Amatom Elect. Hardware	New Rochelle	NY
06665	Precision Monolithics Inc.	Santa Clara	CA
06776	Robinson Nugent, Inc.	New Albany	IN
06915	Richco Plastics, Co.	Chicago	IL
07088	Kelvin Electric Company	Van Nuys	CA
07263	Fairchild Camera & Instr.	Mt. View	CA
07387	Birtcher Corporation	Los Angeles	CA
07556	Omitron Calsaro Plastics	Upper Darby	PA
07633	Epoxy Prod. Co., Allied Prod. Corp.	New Haven	CT
07707	USM Corp. (USM Fastener Div)	Shelton	CT
07716	IRC Incorporated	Burrington	IA
07910	See Code 815818		
08028	Loctite (Auto & Consumer Grp)	Mtn View	CA
08057	Speng Ind., Cosmetics Div)	Sandy Lake	PA
08065	Accurate Rubber and Plastics	San Diego	CA
08261	Spectra Strip (Amphenol)	Garden Grove	
08289	Allen Cwibert Co.	Pomona	CA
08353	Bristol Co. of Canada	Toronto, Ont	Canada
08730	Oakby & Barton (Vemaline Prod. Div.)	Warwick	RI
08779	Signal Transformer	Brooklyn	NY
09214	GE (Semiconductor Prod. Div)	Auburn	NY
09353	C & E Components	Newton	MA
09922	Burndy Corp.	Norwalk	CT
10389	Chicago Switch	Chicago	IL
11815	Cherry/Textron (Fastener Div)	Santa Ana	CA
12406	Elpac Electronics	Santa Ana	CA
12697	Clarostat Mfg.	Dover	NH
12103	Thermalloy Company	Dallas	TX
13150	Vernitron Corp (Beco Prod.)	Lacenia	NH
13606	Sperry Corp. Elec. Systems	Great Neck	NY
13919	Burr-Brown	Tucson	AZ
14099	Semtech Corporation	Newbury Park	CA
14464	Elmwood Sensors Inc.	Cranston	RI
14655	Cornell-Dubilier Elect. Corp.	Newark	NJ
14726	Hollingsworth Co.	Phoenixville	PA
14752	Electro Cube, Inc.	San Gabriel	CA
14908	Electronic Instrument and Specialty Corp.	Stoneham	MA
15238	ITT Semiconductors	Lawrence	MA
15454	Amatom Emi (Rodam Div)	Anaheim	CA
15636	Elec-trol	Northridge	CA
15801	Fenwall Electronics	Framingham	MA
15818	Amelco Teledyne, Inc.	Mt. View	CA
15912	Ansley	Los Angeles	CA
16047	California Instruments Co.	San Diego	CA
16758	Delco Radio Div., Gen. Mtrs.	Kokomo	IN
16956	Dennison	Framingham	MS
17456	Siliconix, Inc.	Santa Clara	CA
18076	Omeco	City of Industry	CA
18178	Vactec, Inc.	Maryland Heights	MO
18310	Concord Electronics Corp.	New York	NY
18324	Signetics	Sunnyvale	CA
18612	Vishay Instruments, Inc.	Malvern	PA
18677	Scanbe Mfg. Co. (Zero Corp.)	Romoley Park	CA
18722	RCA	Mountaintop	PA
18736	Voltronics Corp.	Hanover	NJ
19000	Robicon Company	Hawthorne	CA
21604	Buckeye Stamping Company	Columbus	OH
21845	Solitron Devices (Semi-conductor Group)	Riviera Beach	FL
22599	Elastic Stop Nut Corp.	Van Nuys	CA
23850	Product Components Corp.	Hastings-on-Hudson	NY
23936	Pometer, Inc.	San Francisco	CA
24011	ECC	Burlington	MA
24355	Analog Devices, Inc.	Norwood	MA
24444	General Semiconductor Ind.	Tempe	AZ
24796	Paravox, Inc.	Paramount	CA
24931	Specialty Connector Co., Inc.	Greenwood	IN
24972	ASG-Telefunken Corp.	Somerville	NJ
25403	Amperex Electronic Corp.	Slatersville	RI
25497	Meter Master	Los Angeles	CA
26485	Marathon Electric Mfg. Corp.	Bowling Green	OH
26868	American Lettler, Inc.	Costa Mesa	CA
27016	National Semi-Conductor Crp.	Santa Clara	CA
27191	Cutler-Hammer, Inc.	Milwaukee	WI
27264	Molex	Downers Grove	IL
27335	B & B Meter & Control Corp.	New York	NY
27556	IMB Electronic Products	Santa Fe Springs	CA
27683	Vero, Inc.	St. Garland	TX
27735	F-Dyne Electronics	Bridgeport	CT
27832	Hughes Aircraft	Newport Beach	CA
28480	Hewlett-Packard Co.	Palo Alto	CA
28520	Herman Mfg. Company (Heyco)	Semilworth	NJ
28606	Schlin Ltd.	Rendale Ont.	Canada
29372	Kenmord Ind. Tridair Ind.	Torrance	CA
29593	Bussco Eng. Inc.	El Segundo	CA
30019	International Components Crp.	Asbury Park	NJ
30161	Aerid Engineering, Inc.	Laconia	NH
30897	Dorsan Company	Sylmar	CA
30983	Electra/Midland (Mepco/ Electra)	San Diego	CA
31827	Buehrle Mfg. Co.	Nanmac	CA
31951	Tridiage, Inc.	Pittsmarg	PA
32293	Interstl	Cupertino	CA
32559	Siver, Inc.	Santa Ana	CA
32997	Bourns Inc. (Trimpot Div)	Riverside	CA
33095	Jewell Electrical Inst. Inc.	Manchester	NH
33335	Logic Dynamics, Inc.	Gardena	CA
33716	Kingsbooher Murray Co.	Los Angeles	CA
33855	Ducommun, Inc.	Los Angeles	CA
33901	Calber Corp.	Irvington	NJ
34218	Hills Mcclellan Co.	Los Alamitos	CA
34333	Siliconi General	Westminster	CA
34649	Intel Corporation	Santa Clara	CA
35007	Aerovox Canada Ltd.	Amherst NS	Canada
35794	Linear Technology, Inc.	Burlington, Ont	CAN
44655	Ohmite Manufacturing Co.	Skokie	IL
45722	Porter-Cable	Clifton	NJ
46384	Penn. Eng. and Mfg. Corp.	Doylestown	PA
50157	Midwest Components, Inc.	Muskegon	MI
50522	Semicon. Electronic Special Products	Capertino	CA
50558	Electronic Concepts, Inc.	Eatontown	NJ
50811	Mouser Corp.	Santee	CA
51167	Arlee Electronics, Inc.	Frownstown	NJ
51508	Accurate Screw Machine Co.	Bedley	NJ
51705	ICO/Rally	Palo Alto	CA
52072	Circuit Assembly Corp.	Costa Mesa	CA
52745	Timco	Los Angeles	CA
53076	Zintex, Inc.	Buffalo	NY
53495	Data Components, Inc.	Gardena	CA
54361	Edwards Sheet Metal Works	Fredericktown	OH
54407	Power-One Co.	Camarillo	CA
55322	Samtek, Inc.	New Albany	NY
55566	RAF Electronic Hardware, Inc.	Seymour	CT
56289	Sprague Electric Company	North Adams	MA
56637	RCD Components, Inc.	Manchester	NH
57640	United Chem-Con Corp.	Philadelphia	PA
57956	Kel-Am, Inc.	Eldon	MO
58474	Superior Electric Company	Bristol	CT
59730	Thomas and Betts Company	Elizabeth	NJ
59993	International Rectifier Semiconductor Div.	El Segundo	CA
60395	Xicor, Inc.	Milpitas	CA
61394	Seeq Technology, Inc.	San Jose	CA
61441	Saromis	Palo Alto	CA
61529	Aromat Corp.	Mamaroneside	NJ
61735	Pulse Engineering, Inc.	Calleque Park	MD
62483	Genetron Corp. of America	Terrance	CA
62643	United Chemicon, Inc.	Rosemont	IL
62786	Hitachi America Ltd.	San Jose	CA
63743	Ward Leonard Electric Co.	Mt. Vernon	NY
63791	Star Micronics, Inc.	New York	NY
70318	Allmetal Screw Prod. Co.	Garden City	NY
70903	Belden Manufacturing Co.	Chicago	IL
71218	Bud Industries, Inc.	Willoughby	OH
71279	Cambridge Thermionic Corp.	Cambridge	MA
71400	Bussman Mfg. Div. McGraw-Edison Co.	St. Louis	MO
71450	CTS Corporation	Elkhart	IN
71468	ITT Cannon Electric, Inc.	Los Angeles	CA
71590	Centralab Div. Globe-Union	Milwaukee	WI
71707	Coto-Coil	Providence	RI
71744	Chicago Miniature Lampworks	Chicago	IL
71785	Cinch Manufacturing Company	Chicago	IL
71984	Dow Corning Corp.	Midland	MI
72136	Electro Motive)	Willimantic	CT
72619	Dialight Corporation	Brooklyn	NY
72699	General Instruments	Newark	NJ
72982	Erie Technological Prod. Inc.	Erie	PA
73138	Beckman Instruments, Inc.	Fullerton	CA
73612	Consolidated Electronic Wire and Cable Corp.	Chicago	IL
73734	Federal Screw Products, Inc.	Chicago	IL
74193	Heinemann Electric Company	Trenton	NJ
74545	Harvey Hubbell, Inc.	Bridgeport	CT
74840	Illinois Condenser Co.	Chicago	IL
74970	E.F. Johnson Company	Waseca	MN
75042	TRW Electronic Components	Philadelphia	PA
75382	Bulke Electric Corporation	Mt. Vernon	NY
75382	Lawton Mfg. Co.	Little Rock	NY
75915	Littelfuse, Inc.	Des Plaines	IL
76185	Minor Rubber Co., Inc.	Bloomfield	NJ
77062	Panel Eng. Equipment Co.	Elizabeth	NJ
77132	United-Carr Inc., Fatwin Div	Watertury	CT
77372	Potter and Bluefield Div, AMF	E. Princeton	IN
78189	Shakeproof Div. IL Tool Works	Chicago	IL
78553	Tinnerman Products, Inc.	Cleveland	OH
79136	Johns-Manville Products Corp	Chicago	IL
79136	Waldes Kohinoor Inc.	Long Island City	NY
79963	Sierick Mfg. Corp.	New Rochelle	NY
80031	Mepco/Electra	Morristown	NJ
80223	United Transformer Co.	New York	NY
80294	Bourns, Inc.	Riverside	CA
80495	High Voltage Engineering Corp (Anderson Pwr Prod. Div)	Brighton	MA
81095	Triad Transformer Corp.	Venice	CA
81312	Winchester Electronics	Oakville	CT
81348	(Fed. Specs) Promulgated by General Services Administration Washington DC		
81349	Military Specification or Commercial Generic Number		
81541	Airpax Corp.	Cambridge	MD
81603	Raco Products Co.	Chicago	IL
81851	Bentley-Harris Mfg Co.	Lionville	PA
82104	Standard Grigsby	Aurora	IL
82389	Switchcraft, Inc.	Chicago	IL
82877	Astron Mfg. Co., Inc.	Woodstock	NY
82893	Vector Electronics, Inc.	Sylmar	CA
83330	Herman H. Smith, Inc.	Brooklyn	NY
83486	Elco Tool & Screw Corp.	Rockford	IL
85480	Brady W.H. Co.	Milwaukee	WI
86684	RCA	Harrison	NJ
86928	Seastrom Mfg. Co., Inc.	Glendale	CA
87034	Marco-Oak Industries	Anaheim	CA
88245	Ceeco Div., Litton Ind.	Van Nuys	CA
90201	Mallory Capacitor Co.	Indianapolis	IN
91508	Augat, Inc.	Attleboro	MA
91637	Dale Electronics, Inc.	Columbus	NE
91662	Elco Corporation	Willow Grove	PA
91802	Industrial Devices, Inc.	Edgewater	NJ
91833	Keystone Electronics Corp.	New York	NY
91947	National Tel-Tronics	Readville	PA
92194	Alpha Wire Corp.	Elizabeth	NJ
93301	Pentagon Products Co.	Washington	DC
94222	Sealtron, Inc.	Exeter	PA
94496	Magnecraft Electric Co.	Chicago	IL
95146	Alco Electronic Prod., Inc.	No. Andover	MA
95303	RCA	Cincinnati	OH
95354	Methode Manufacturing Corp.	Rolling Meadows	IL
95566	Arnold Engineering Co.	Marengo	IL
95987	Mechanex Company, Inc.	Chicago	IL
96906	Military Std		
97525	Electronic Engineering Co.	Santa Ana	CA
98159	Rubber Tech, Inc.	Gardena	CA
98291	Sealecto Corp.	Moonachaug	NY
98378	Ieco Mfg. Co. (West)	Burbank	CA
98978	IERC	Burbank	CA
99017	Protective Closures Co., Inc. (Capimpe Div)	Buffalo	NY
99217	Bell Industries, Inc.	Delevan	WY
99742	Permacell	New Brunswick	NJ
99743	IMC	Heywood	CA
99800	Delevan Electronics Corp.	Aurora	NY

Revision K
June 17, 1986

ONE YEAR WARRANTY

CALIFORNIA INSTRUMENTS, Division of Amstar Technical Products Co., Inc., warrants each instrument manufactured by them to be free from defects in material and workmanship for a period of one year from the date of shipment to the original purchaser. Excepted from this warranty are tubes, fuses, and batteries which carry the warranty of their original manufacturer where applicable. CALIFORNIA INSTRUMENTS will service, replace, or adjust any defective part or parts, free of charge, when the instrument is returned freight prepaid, and when examination reveals that the fault has not occurred because of misuse, abnormal conditions of operation, user modification, or attempted user repair. Equipment repaired beyond the effective date of warranty or when abnormal usage has occurred will be charged at applicable rates. CALIFORNIA INSTRUMENTS will submit an estimate for such charges before commencing repair, if so requested.

PROCEDURE FOR SERVICE

If a fault develops, notify CALIFORNIA INSTRUMENTS or its local representative, giving full details of the difficulty, and including the model number and serial number. On receipt of this information, service data or a Return Material Authorization (RMA) number will be given. Fill in RMA No. blank on shipping label attached opposite these instructions, pack instrument carefully to prevent transportation damage, affix label to shipping container, and ship freight prepaid to the factory. CALIFORNIA INSTRUMENTS shall not be responsible for repair of damage due to improper handling or packing. Instruments returned without RMA No., or freight collect will be refused. Instruments repaired under Warranty will be returned by prepaid surface freight. Instruments repaired outside the Warranty period will be returned freight collect, F.O.B. CALIFORNIA INSTRUMENTS, San Diego, CA. If requested, an estimate of repair charges will be made before work begins on repairs not covered by the Warranty.

DAMAGE IN TRANSIT

The instrument should be tested as soon as it is received. If it fails to operate properly, or is damaged in any way, a claim should be filed immediately with the carrier. A full report of the damage should be obtained by the claim agent, and a copy of this report should be forwarded to us. CALIFORNIA INSTRUMENTS will prepare an estimate of repair cost, and repair the instrument when authorized by the claim agent. Please include model number and serial number when referring to the instrument.

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